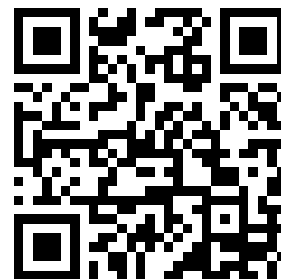

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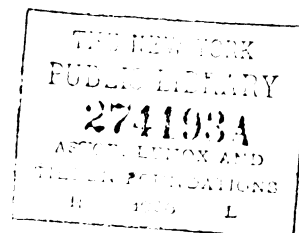
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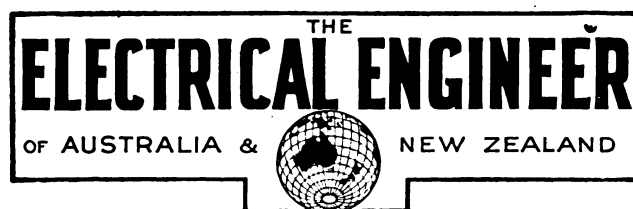
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Editorial





OUR ANNIVERSARY

With this number the "Electrical Engineer of Australia and New Zealand" enters a new year. In the short period which has elapsed since its establishment the journal has made wonderful progress, and has demonstrated that the publishers were correct in their belief that the rapid expansion of the electrical industry justified a journal wholly devoted to electrical matters. For many years the publishers catered for the electrical field through their other publications, notably the "Commonwealth Engineer," and many expressions of appreciation for the services rendered to the industry have been received from electrical engineers, manufacturers and traders.

We take this opportunity to thank all who have helped to make the "Electrical Engineer" a success, advertisers, contributors and subscribers. The support of these three classes is necessary, and it will be the aim of the editors and publishers in the future, as in the past, to produce a journal which will warrant their continued appreciation. Journals such as this do for more for the industries which they represent than is generally recognised. By hearty co-operation on the part of readers the "Electrical Engineer" is enabled to broadcast information which is of service to every branch of electrical engineering. The main directions in which readers can further the interest of the journal are: (1) by submitting articles, news items, photographs of technical interest, personal paragraphs and the like, (2) by bringing it under the notice of their friends, and (3) by mentioning it when writing to advertisers.

In this anniversary issue there will be found a number of interesting articles including the following:—Ballarat and Bendigo Electric Supply and Tramway Undertakings; Submarine Telephone Cables; Early History of Electric Supply in Victoria; Inspiration of Past Achievements; Regulation of A.C. Generators. In addition, there are many interesting items of news from all parts of the world and reports of electrical supply and tramway undertakings in our own field.

THE JUSTICE OF A NON-CONSUMERS' RATE.

New Zealand is blessed with power resources which are the envy of many less fortunate countries. These, through the wise policy and foresight of those who have had the directing of the Dominion's affairs, are being developed and

utilised in a very efficient and satisfactory way. The Government taps the national resources for the benefit of all, and the power thus made available is distributed by the local authorities in the manner best suited to the needs of each district. The progress that has been made during the last few years in the establishment of generating stations, and the reticulation of both town and country districts, indicates that the methods adopted have proved sound in practice. But, in spite of the success of the whole scheme of development, there are still some persons who would decry it. Because a certain aspect of the business appears to be adverse to their own immediate personal interest they demand, in effect, that progress be held up.

At a meeting held recently in the territory under the jurisdiction of the Thames Valley Power Board several resolutions were passed which, if acted upon, would have the effect of seriously retarding electrical development. The meeting stated as its opinion that, "The levy of a separate rate against non-consumers, which means compelling them to pay for electricity irrespective of whether they need it or can afford to pay for its installation and consumption, is entirely unjust." It also, "Earnestly petitions the Government to consider taking over in its entirety the generation, transmission and supply of electrical energy throughout the Dominion." Such resolutions display pitiable ignorance of the principles of justice, and of the economics of a great national public utility. In view of the present establishment and development of electric power boards the second quotation may be dismissed as harmless talk; the first, however, requires further consideration.

In order to ensure success to any large scheme for distribution of electric power it is necessary that the loading density be kept at the highest possible figure. This is particularly applicable in country districts where consumers are comparatively few per unit length of line. If prices of energy are to be kept reasonable it is essential that every available consumer in a district be connected up. The authorities, in framing the regulations which govern the operations of the power boards, gave full recognition to this fact. They also recognised that, owing to the vagaries of human nature, there would probably be some persons in each district who, blind to their own advantages and selfishly ignoring their duty to assist their neighbors in obtaining cheap service, would refuse to take the power supply when it was available. In order, therefore, to protect

those who recognised the benefits of electricity and were willing to co-operate in the national development, the Government gave the power boards the right to levy a rate on all non-consumers. It is hard to see how such a rate can be classed as unjust; indeed, it would be unfair to the consumers were it not levied.

It is somewhat surprising that, in a community where power is abundant and reasonably priced, there should remain persons who render themselves liable to a non-consumers' rate. The benefits of electric supply are so obvious that it is difficult to understand any person not wishing to avail himself of it. Surely there is nothing unfair in a levy which is really an urge to every householder to take steps to benefit himself. There is still another sound reason why the non-consumer should help to pay for electric supply for his district. The very availability of the service is an enhancement of the value of his property, even if he decides not to use it. Does he expect his more enterprising neighbors to benefit him without him making any return?

There may possibly be something to be said for the man whose circumstances are such that he cannot afford the capital outlay necessary for an electrical installation, but there are not likely to be many in this category amongst householders. In any case the rate is proportional to the value of the property, and imposes no hardship on the man of small means. The whole question appears to be merely a matter of short-sightedness and selfishness, and it is to be hoped that the Government will take no notice of such parochial pettiness, but will continue on the sound lines that are proving so successful.

NEW TYPE OF LOCOMOTIVE REQUIRED FOR TRANSCONTINENTAL LINE

The Commonwealth railway department is experiencing a considerable amount of difficulty with the maintenance of the locomotives operating on the transcontinental line. The only water available along many portions of the route is from artesian bores, and this is having a very serious effect in corroding the locomotive boilers. Strenuous efforts have been made to overcome the difficulty, but so far with little success, so that it appears that the use of some new type of locomotive will have to be resorted to in order to keep maintenance costs within bounds.

Amongst the alternatives which are under consideration is the use of turbine condensing locomotives. Several machines of this type have recently been developed, although as yet they are hardly past the experimental stage. The Ljungstrom locomotive has a non-reversing turbine,

which develops 1,800 h.p., driving through double reduction gearing and by means of connecting rods to the wheels. Reversing is accomplished by interposing an idle pinion in the drive. The Reid-McLeod locomotive also drives through double reduction gears. The Krupp-Zoelly locomotive has a forward and a reverse turbine and drives through gears to a jack shaft. Certain types have also been developed using electric drive for the transmission, but, although the drive is excellent and the efficiency high, they have the disadvantage of high first cost and heavy weight for the power developed.

It is very probable that if any of these types are used oil firing will be resorted to in order to further increase efficiency. A turbo-condensing locomotive with oil firing should be able to carry sufficient fuel and water, including condenser circulating water, for a complete transcontinental trip. Trials on condensing locomotives have demonstrated that in spite of the necessary limitation in quantity of cooling water it is possible to maintain a vacuum of $27\frac{1}{2}$ in. While it is not essential to use turbines in conjunction with the condenser for a locomotive, such a course will be found to have advantages owing to the higher economy of the turbine over the reciprocating engine.

The possibilities of internal combustion locomotives are now being carefully investigated in many places. Here the electric transmission appears to offer the most efficient and reliable solution of the problem of applying the power to the wheels in a flexible manner. In a recent number of the Electrical Engineer a short description was given of a heavy duty oil electric switching locomotive recently built in the United States. The chief disadvantage of such a unit appears to be its first cost, which is estimated at about 1.8 times that of a steam locomotive of equal capacity. At the same time its efficiency is very much higher than that of the steam locomotive, and, particularly in a situation like that which has arisen on the transcontinental line, its low maintenance has a decided appeal. Here again, however, the type is scarcely out of the experimental stage.

It appears that whether the choice lies with the turbo-condensing or the internal combustion type of locomotive for this application, consideration will have to be given to the claims of electric transmission. In both types the power transmission is the chief difficulty, in the first because the turbine is not reversible, in the second because the engine is not reversible and must be provided with some arrangement to allow it to run idle when the locomotive is stationary. For small powers a clutch and gear arrangement is satisfactory for internal combustion engines, but when it comes to transmitting 1,000 h.p. or more the electric system appears to offer the only feasible proposition.

Notes and Personals

Mr. R. Hollis has been appointed engineer-in-charge of the Dorrigo hydroelectric works, N.S.W., in succession to Mr. Gardiner, resigned.

Mr. T. M. Carey, M.Inst.C.E., M.I.E., Aust., electrical engineer to the Perth city council, has been appointed manager of the Adelaide branch of the Hume Pipe Co.

Mr. A. P. Aldrige has been appointed engineer-manager, Mr. J. C. Collins, assistant engineer, and Mr. W. A. Dunstan draftsman, to the Otago electric power board, N.Z.

The New South Wales cabinet has decided to appoint forthwith an expert committee to inquire into electricity supply as affecting Sydney and its environs, also the whole of the state.

Mr. H. Clement Newton, engineer and manager in Australia and New Zealand for British Insulated and Helsby Cables Ltd., sailed by R.M.S. "Oronsay" for a short visit to his company's head office in England.

Mr. Oakes, Chief Secretary, New South Wales, has authorised trials of double-decker motor 'buses in the Sydney metropolitan area over a period of three months.

The Westinghouse Electric and Manufacturing Co., U.S.A., and Siemens-Schuckert Co., Germany, have entered into a ten-year "patent, experience and practice" agreement whereby each company will benefit mutually from the research, inventive genius and electrical methods of the other.

Mr. E. Connelly has been promoted to the position of engineer in charge of the electric supply undertaking at Horsham, Vic., in succession to Mr. B. A. Morris, who has joined the staff of the Vacuum Oil Co.

Mr. T. M. Ritchie, managing director of Metropolitan-Vickers (Australia) Pty. Ltd., intends making Sydney his headquarters. Reference to the new works being erected at Lidcombe will be found in another column.

Mr. W. Corin, consulting engineer, Sydney, visited Victoria and Tasmania last month. Whilst in Victoria he inspected the works of the electricity commission at Yallourn, also the hydroelectric development at Sugarloaf.

Approval has been granted by the New South Wales Parliamentary Works Committee for the construction of an electric railway from St. Leonards to Eastwood, a distance of slightly over eight miles. The estimated cost is £649,600.

Captain Percy E. Wright has resigned the office of private secretary to Sir James O'Grady, Governor of Tasmania, in order to act in a similar capacity to Mr. Edward Hirst, managing director of the British General Electric Co. Ltd., Sydney.

Executive approval has been given to the appointment to the Electrical Workers' Board, Queensland, of Messrs. P. S. Trackson (representing the electrical employers), S. J. Bryan (representing the employees), and T. F. Neilson (representing the electrical trade union).

Mr. E. Harland Hutchinson, a specialist in the burning of pulverised coal, has accepted a position with Vickers and International Combustion Engineering Ltd., owners of the Lopulco system of pulverised fuel firing. Mr. Hutchinson is shortly visiting Australia via U.S.A. and Canada.

Mr. R. Cecil Creasey, electrical engineer to the municipality of Albury, N.S.W., has resigned his position. The reason given was that he felt he no longer had the confidence of the council since he had not been supported in a complaint made regarding an employee at the power house.

Mr. G. H. Battersby, B.Sc., has been appointed assistant electrical engineer to the city council of Christchurch, N.Z. He received his early technical training in New Zealand, proceeding later to the London University. His experience has been obtained partly in London and partly in the New Zealand public works department.

Mr. F. W. Wheadon, general manager of the Adelaide Electric Supply Co., sailed by the Mongolia on a visit to Europe and America. He expects to be in Paris in June to attend the international conference of large extra high tension electric supply systems, as the representative of the South Australian section of the Institute of Electrical Engineers. He is accompanied by Mrs. Wheadon.

At the request of various electrical traders, the Electrical Employers' Association of N.S.W. has made arrangements with the Fire Underwriters' Association and the Sydney city council to extend the date of operation of wiring rules numbers 24 and 34, until July 1.

Mr. A. U. Alcock, who is at present abroad, will attend the international conference of large extra high tension electric supply systems at Paris in June, as the representative of the Institution of Engineers, Australia, and of the Victorian and Tasmanian section of the Institute of Electrical Engineers.

The Auckland power board, N.Z., has adopted a scheme for ensuring prompt attention for consumers in the event of mishaps occurring in the service after working hours. When a breakdown occurs at a time when the board's own men are not on duty, the board will supply enquirers by telephone with the name and address of an electrical contractor in the vicinity who is prepared to effect repairs at once. In such cases the question of payment for replacements in the consumer's installation will rest between the consumer and the contractor.

With a view to encouraging the use of domestic power devices, the Adelaide Electric Supply Co. has reduced the tariff applying to this class of load to 2½d. per unit. Although this is expected to materially increase the demand, particularly for such applications as cooking, the general manager of the company considers that the domestic load cannot make any great advancement until prices of apparatus are considerably reduced.

The twenty-seventh annual gala day conducted by the officers of the Australian Gaslight Co., North Shore Gas Co., Manly Gas Co., and the Electrical Employer's Association, N.S.W., was held in Sydney on Mar. 18. Challenge events in cricket, tennis, bowls and golf were played between representatives of the gas and electrical interests. The day's play resulted in victories for gas in second eleven cricket, and bowls, while the electrical representatives were victorious in first eleven cricket, tennis and golf. In the evening of the same day the annual dinner took place in the pavilion of the Sydney cricket ground, Mr. C. U. B. Gurnett, of the Australian Gaslight Co., acting as chairman.

Mr. A. Cameron chairman of the Melbourne tramways board, has stated that if the present serious handicaps to the tramway operations are allowed to continue it may possibly be necessary in the near future to strike a municipal rate to make up losses on the working. Motor bus competition is proving very serious, and in addition the board has to pay an annual contribution towards the maintenance of the fire brigade and the infectious diseases hospital. To meet these and other charges, a sum of £125,000 had to be withdrawn from the board's reserve fund last year.

At a meeting of the Queensland electrical workers' board, on March 3, several breaches of the act, by the employment of persons not holding the requisite certificates, were brought under notice. Five applications for permission to sit for examinations for certificates of competency were granted, and ten persons were granted certificates without examination.

AN UNPROTECTED SWITCH.

An employee at the Hawthorn, Vic., garbage destructor recently lost his life through coming into contact with an electric light switch which was without a cover. The man was standing on some wet garbage and leaned against the switch which, it was stated, had been without a cover for at least five weeks. No report had been made regarding the condition of the switch, although another employee had received a shock some three weeks previously. The circumstance indicates either negligence on the part of those responsible for the maintenance of the plant, or ignorance of the seriousness of allowing electrical apparatus to remain unprotected in such a situation.

ELECTRICAL ENGINEER INDEX.

The index to Vol. 1 of the "Electrical Engineer" is now in the press. A copy will be forwarded to any subscriber who makes application to the publishers.

THE TECHNICAL INSTRUCTORS' SOCIETY OF VICTORIA

At the first council meeting on Saturday, April 4, the officers of this society for 1925 were elected as follows: President, Dr. H. J. Schapper; Senior Vice-President, Mr. W. R. Dean; Junior Vice-President, Mr. R. Dorey; Secretary, Mr. R. C. Armstrong; and Treasurer, Mr. G. E. Graham. The council consists of the following members: Messrs. W. Bruce (West Melbourne), W. H. Davies (Footscray), W. R. Dean (Prahran), R. Dorey (Caulfield), G. E. Graham (Swinburne), A. T. Heseltine (Ballarat), J. R. Tranthim-Fryer (Swinburne), G. R. King (Geelong), C. F. Mudie (Footscray), J. Sarvaas (Working Men's College), H. J. Schapper (Footscray), and G. S. Serpell (Sth. Melb.).

A.G.E. INTER-OFFICE REUNION

In order to provide members of the various state office staffs with an opportunity for personal meeting and general fraternising the Australian General Electric Co. arranges each year a series of social events including sports, trips of local interest, dances and theatre parties. This year the meeting took place in Sydney during the period Mar. 14 to 17 inclusive. In accordance with the usual custom of the state receiving visitations, the interstate visitors were met at the central railway station and escorted to the Hotel Sydney for luncheon. During the afternoon the annual picnic and sports meeting was held at Sandringham. In the evening a social, which included dancing, musical items, games, etc., was provided. On the following day there was a motor outing to Newport, via Five Bridges and French's Forest, returning by way of Church Point to Manly. After surfing, tea was provided and the return to Sydney commenced at 8.0 p.m.

The chief event of the tour was the inter-office cricket match between teams representing Melbourne and Sydney, which was played on the 16th and 17th. The match resulted in a win for the home side by an innings and seven runs. Before returning home the visitors paid tribute to the excellent arrangements for their entertainment. Ideal weather contributed in no small measure to the success of the brief vacation.

Electrical Progress at Ballarat and Bendigo, Victoria

The cities of Ballarat and Bendigo, which are situated respectively at distances of about 75 and 100 miles from Melbourne, owe their original existence to the gold mining industry. Although there has been a marked falling off in population with the decline of mining activities, a degree of stability has now been attained which is far higher than any purely mining city could show. This is primarily due to the development of each city as the commercial centre of its surrounding agricultural district, but the position is growing even more secure with the establishment of secondary industries. The present population of Ballarat is about 39,700, while that of Bendigo is 33,400.

It may be said that the stable progress of each city is faithfully indexed by the expansion of its electric supply undertaking. The Electric Supply Co. of Victoria Ltd., which took over from existing authorities in both cities, operates the electricity supply and tramway services. The company commenced operations in Bendigo in 1903 and in Ballarat in 1905. The franchise under which it operates in the former city is due to expire in about six years' time while in the latter it has about seven years to run. The power station equipment in the two cities is very similar, and the company has recently made considerable extensions to the plant in both undertakings. Mr. P. J. Pringle is chief engineer and general manager to the company, while Mr. D. Maxwell and Mr. G. F. Cole are the resident engineers at Ballarat and Bendigo respectively.

Ballarat Undertaking

The first units of generating plant installed by the company at Ballarat comprised three Browett-Lindley vertical high speed steam engines, each direct coupled to a 300 kw. Silver-town generator. Steam was supplied by three Stirling water tube boilers, operating at 160 lb. per sq. in. pressure, each capable of evaporating 12,000 lb. of water per hour, and equipped for burning wood fuel. The boiler house auxiliary equipment consisted of two Weir feed pumps and a Green economiser. The flue gases were conveyed to a single brick chimney. The reciprocating engines exhausted to Koerting jet condensers. The circulating water was brought down in temperature by means of a cooling tower of the usual design, equipped with troughing and retarding louvres. Additional make up circulating water was supplied from the town mains, as was also the make up feed water. (The water supply is pure and soft, giving no trouble. There is a certain amount of matter in suspension, as is inevitable, but this

has no effect except in forming a slight red deposit in the boilers after running for a considerable period.)

The generators were compound wound and could be operated either at 550 or 440 volts by cutting in or out the series winding. This provision was made owing to the variation between the voltages of the traction supply and the lighting and power supply. In addition to the generating sets an 80 kw. motor generator, supplied by the British General Electric Co. was installed. This consisted of a 550 volt motor direct coupled to a 440 volt generator. This machine provided for supplying light loads for lighting and power from the traction supply, thus effecting economy by necessitating the running of one prime mover only. The 220 volt lighting load was provided for by one double armature and one single armature balancer floating across the 440 volt supply.

An Austral Otis vertical tandem compound engine was also installed. This was arranged for driving the double armature balancer through a rope drive and clutch thus providing an additional 100 kw., 440/220 volt generator for supplying light loads. The clutch was provided so that the balancer could be disconnected from the engine if required, enabling it to perform its original function. At a later date an alteration to the boiler equipment was made in the conversion of two of the boilers to slack coal firing. Bennis automatic chain grate stokers were installed on these, but the third was still retained for wood fuel.

The main switchboard was supplied and erected by the British General Electric Co., and comprised the customary generator and feeder panels, equipped with air break circuit breakers, switches, meters, etc., mounted on white marble. The whole of this original power station equipment is still intact and in running order, the reciprocating sets being maintained for standby purposes.

In 1912 the plant was increased by the addition of a 450 kw. Brush-Parsons mixed pressure turbo-generator set. The turbine exhausts to a Brush surface condenser, and the auxiliaries comprise a three throw Edwards air pump and a Brush-Drysdale motor drive circulating pump capable of dealing with 80,000 gal. of water per hour. When operating on exhaust steam from the reciprocating sets at approximately $1\frac{1}{2}$ lb. per sq. in. above atmosphere this set is capable of supplying a load of 300 kw. Utilising the exhaust steam in this manner was found to be generally more economical than the use of the Koerting jet condensers.

In conjunction with the mixed pressure set a Rateau heat accumulator was installed. This consists of a large vertical lagged steel cylinder interposed on the steam line between the reciprocating engine exhaust header and the low pressure inlet of the turbine. The cylinder contains a number of horizontal trays fitted with numerous short vertical overflow pipes. The steam enters at the bottom of the cylinder and

ever, for returning to the hotwell any excess water above a certain amount. The heat accumulator, which soon becomes warmed to the exhaust steam temperature, acts as a balancer between the reciprocating engine exhaust and the turbine inlet. Its action in effect is that of a flywheel, for when the load on the reciprocating engine exceeds that on the turbine the accumulator stores energy in the form of

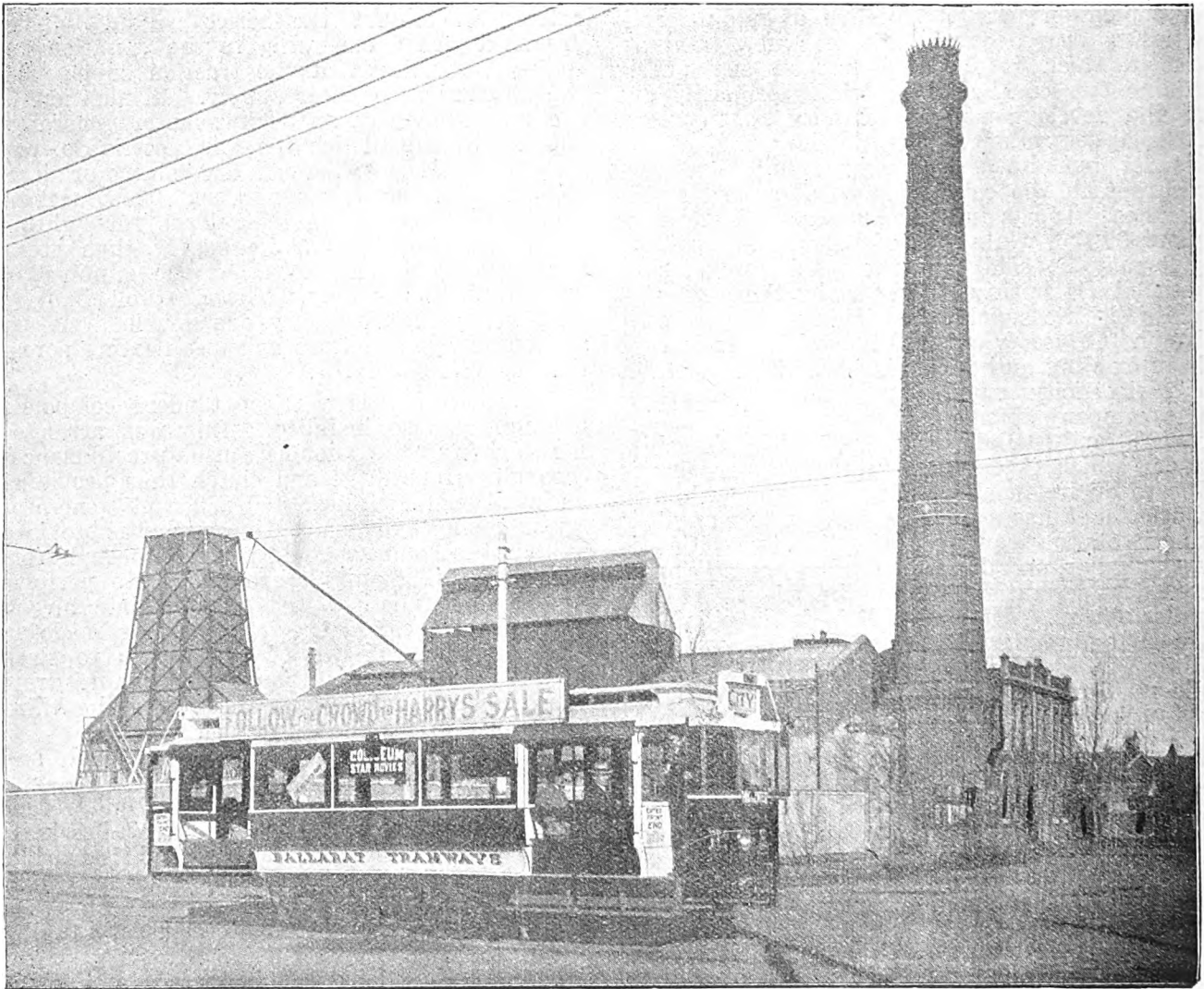


Fig. 1. Power Station and One-Man Car, Ballarat

passes upwards through these pipes. At the commencement of operations the accumulator is cool and a considerable amount of the steam condenses, the water collecting in the trays. When the trays become filled the water overflows down the pipes, falling to the bottom of the accumulator. A small motor driven pump takes charge of this overflow, raising it again to the top of the accumulator and maintaining a constant circulation. Provision is made, how-

hot water at the slightly increased back pressure, while when the turbine demand increases the energy is given up through the evaporation of the water supplying extra steam as the pressure falls. Some arrangement of this nature is a necessity in order to get full economical working with the exhaust steam. In the case when the turbine and reciprocating engine are working in parallel supplying the same load a balance could be obtained

without an accumulator by regulation at the electrical end, but when the reciprocating set is supplying traction and the turbo set lighting and power no such balance is possible.

The turbine runs at 2,600 r.p.m. and is direct coupled to the generator which is of the inter-pole type generating at 480 volts. In spite of

carrying continuous overloads up to 50 per cent above normal rating for long periods. The only trouble that the set has experienced was due to the melting of the solder in the armature end connections brought about by the heavy overloading. The set has been put together again after overhaul without repair or replacement of

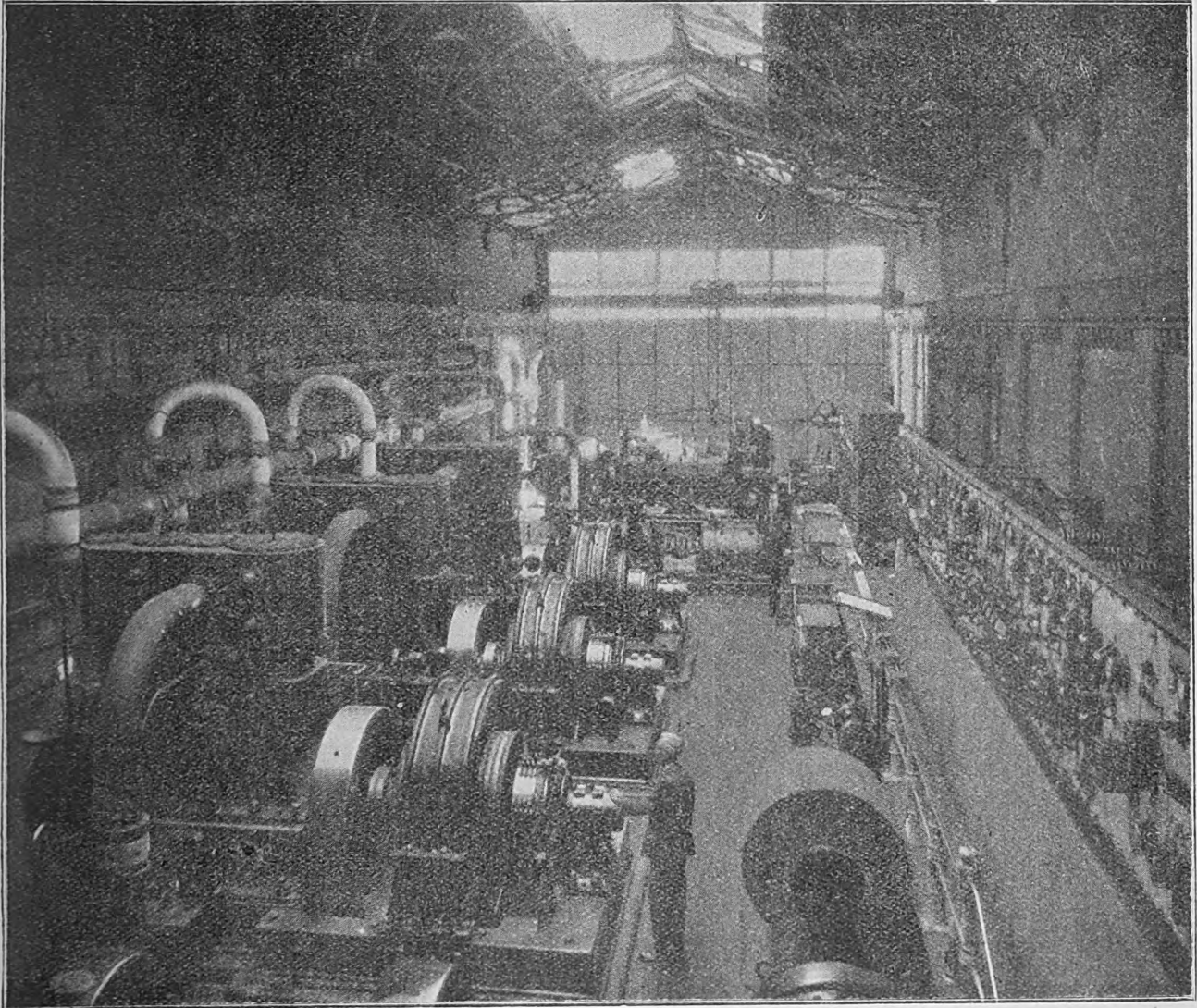


Fig. 2. Engine Room of Electric Supply Station, Ballarat

the high speed no commutation trouble has even been experienced with this set. Indeed the set has proved thoroughly reliable in all respects and the operating engineers are very pleased with its performance. It has just been taken down for overhaul after somewhat over 10 years continuous service and the only signs of age in any part are a slight evidence of wear on the blading of the first and last stages, and a trace on the blades of the red deposit previously mentioned as noticeable in the boilers. During this period the set has run approximately 16 hours a day for six days in the week, often

any part, and is expected to give efficiency almost equal to new.

About the time the mixed pressure set was installed an addition was made to the boiler plant by the installation of a fourth Stirling boiler of 12,000 lb. per hour capacity. This boiler is equipped with a superheater for increasing the steam temperature by 170 deg. F. and has a Babcock and Wilcox automatic chain grate stoker for burning slack coal.

It was later found necessary to increase the capacity of the plant for dealing with the circulating water, and accordingly some two years

ago an additional cooling tower was erected. This tower was designed by the company's engineers, and is in reality a shielded spray pond. The circulating water is pumped into an elevated tank whence it is conveyed through piping to two sets of spray nozzles, one set operating at a head of 15 ft. and the others at 25 ft. head. The water falls to a concrete floor whence it flows back to the circulating pumps. The whole arrangement is enclosed in galvanised iron shielding supported on a wooden framework, entirely open at the top and allowing free access of air at the bottom. Thus the air circulates through the bottom and up and out at the top. This tower has been found quite efficient and satisfactory. The old and new towers together are at present dealing with and satisfactorily cooling about 80,000 gal. of water per hour.

During last year, in order to further increase the efficiency of the plant, a 45 in. Sirocco induced draft fan was installed at the base of the chimney. This fan is belt driven by a Robison vertical high speed steam engine, and materially improves the draft conditions. In order to further increase the boiler efficiency new superheaters, which are at present in course of manufacture by Messrs. Thompson & Co. of Castlemaine, Victoria, are to be installed in the three original boilers.

During the war period and in the ensuing years the load demand of the district increased to an extent that put a very severe tax upon the plant. The reliability of the equipment, however, carried the company through, and it was able to give supply without any restrictions until such time as new arrangements could be made. Consideration was given to taking bulk supply from the electricity commission, but the company finally decided to increase its generating plant, and tenders were accordingly called for two 1,000 kw. turbo-alternator sets. At the same time precisely similar plant was called for for extensions to the Bendigo station. None but British and Australian tenders were considered, and the final decision was given in favor of the Brush Electrical Engineering Co. Ltd., England. This company offered as an alternative two 1,400 kw. sets for each station on such favorable terms that the Electric Supply Co. placed the order for sets of this capacity. In making the decision in favor of the Brush sets the company was largely influenced by the low steam consumption guarantees, especially on half and quarter loads, which the Brush Co. was able to give.

The new sets are now installed and in running order. They consist of two 1,750 kv.a., 6,000/6,600 volt, 50 cycle, three phase, 3,000 r.p.m. Brush-Ljungstrom turbo-alternators, with Brush surface condensers, complete with auxiliaries. There are many points of special interest in connection with these sets, and a more detailed description will be given later. The turbo-alter-

nators are at present supplying the full load. The alternating current is taken to two Brush transformers where it is stepped down to supply one 500 kw. and one 300 kw. British Thomson-Houston rotary converter. The larger machine supplies the lighting and power load at 440/220 volts, the 220 volt supply being obtained by taking the mid wire back to the neutral point of the six phase, star connected transformer secondary. The smaller converter supplies traction energy at 550 volts, but the transformer feeding it is tapped so that, by means of a change-over switch, the rotary may be placed on either 394 or 354 volts a.c. supply, in order to provide energy for traction or lighting as required. Both the converters, with their transformers, are rated to take an overload of 25 per cent for two hours, or of 50 per cent for one minute.

A new 6,600 volt a.c. switchboard of the steel cubicle type has been erected in conjunction with these extensions. It was manufactured at the English works of Messrs. Ferguson Pailin Ltd. and comprises two generator panels, a meter panel, two converter panels, and three feeder panels. The equipment consists of oil switches and the usual range of instruments with their accompanying transformers. The synchronising instruments are mounted on a swing bracket at one end of the board. Merz-Price protection is applied to the generators, and the relays are mounted on the face of the switchboard. Each generator field is regulated by series control of the exciter field. The regulators are hand wheel operated, and are placed on the floor in front of the switchboard. An air break circuit breaker for opening the exciter field is mounted on a short pillar placed adjacent to each regulator.

In addition to the high tension switchboard three further panels have been added to the d.c. board to take the supply from the rotary converters. These are equipped with B.T.H. air break circuit breakers with overload and reverse current protection, and the usual instruments. In addition the panel for the smaller rotary mounts a change over knife switch for making connection to the traction or lighting load as required. Each rotary is equipped with an over and under speed device connected to the trip coil of its circuit breaker, which will throw on the load in the event of any abnormal running.

The distribution system is at present all direct current. There are 78 miles of street mains, including 6½ miles of underground cable in the central portion of the city. Now that alternating current supply is available it is proposed to change over to a.c. on all the outlying portions of the city, although d.c. will be adhered to in the central parts. Steps are being taken already to change over the supply to Ballarat East, and the material for the conversion is now on

pressure of motor bus competition. One man operation has enabled them to keep going, in face of increasing costs, up to date, in spite of the fact that the city is really scarcely large enough to maintain tramways. The new competition, however, has made matters very difficult. The city council has framed regulations confining the buses to fixed routes and schedules but the buses still have an advantage in that their contribution to road maintenance is not nearly so heavy as that of the trams. With the competition on a fair basis, however, the trams should be able to hold their own as they provide a very reasonable service.

Bendigo Undertaking

As previously stated the development of the Bendigo undertaking has been along very similar lines to that at Ballarat. The original generating plant consisted of three 300 kw. Browett-Lindley Silvertown sets. An 80 kw. motor

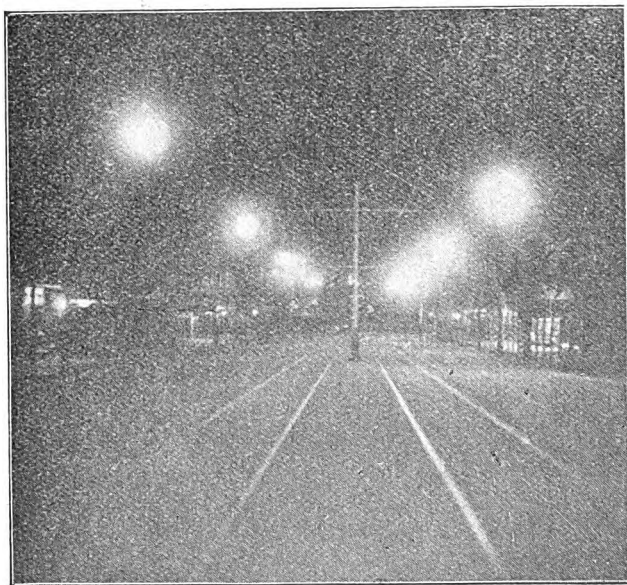


Fig. 4. Lighting in Mitchell Street, Bendigo

generator was installed for dealing with light loads, and the 220 volt supply was provided by means of one double armature and one single armature balancer. Steam was supplied by three 12,000 lb. per hour Stirling boilers, equipped with Babcock and Wilcox chain grate stokers of 68 sq. ft. area for burning slack coal. Two Weir feed pumps and a Green economiser were installed, and the boilers were operated on the natural draft of a single brick chimney. The exhaust steam from the reciprocating sets passed through a common header to one Wheeler and one Mirrlees-Watson surface condenser placed outside the engine room building. The condenser auxiliaries consisted of two sets of Mirrlees-Watson air extraction and circulating

pumps, each driven by a Brush motor. The circulating water was cooled by means of a spray pond.

In 1910 two additional generating sets were installed, consisting of Belliss and Morcom engines driving respectively a 100 kw. Phoenix and a 300 kw. Silvertown generator. A little later a fourth 12,000 lb. per hour Stirling boiler with superheater and Babcock and Wilcox stoker was added. Additional nozzles also were installed in the cooling pond, bringing the total up to the present number, 75. The whole of this plant except the motor generator set is still in running order. The latest additions have been made in conjunction with those at Ballarat, and comprise two 1,750 kv.a. Brush Ljungstrom turbo-alternators, with auxiliaries, transformers, rotary converters and switchboard, identical in all respects with the Ballarat plant.

The distribution system is at present all direct current, but work has been commenced on changing over the outer areas to a.c. The present reticulation comprises 67 miles of overhead mains and 15 miles of underground cables. The consumers total 4,025 and the total connected load is 5,309 kw. The units sold during the twelve months ended March 31, 1924, totalled 2,768,000 and the maximum demand was 958 kw. Street lighting is supplied through 45 miles of overhead and seven miles of underground mains. Half watt lamps are used throughout, and in two of the principal streets a special scheme of lighting has been adopted. In Hargreaves street a single row and in Mitchell street a double row of 600 c.p. half watt lamps with enamelled iron reflectors are suspended above the roadway. This lighting is paid for jointly by the city council and the shopkeepers, the latter contributing in proportion to the rating value of their properties. The efficiency of the illumination may be judged from the illustration.

In addition to supplying the city and suburbs of Bendigo the supply company provides energy for the late night load in the adjacent borough of Eaglehawk. The borough council operates an 110 kw. suction gas plant, but finds it more economical to purchase current from Bendigo for the light load period than to run either of its own generators. It is only possible to supply very small loads by this means as the voltage drop over the d.c. feeder would otherwise be too great.

The Bendigo tramway system comprises 8 miles 9 ch. of route length. There are two routes, the Lake route, under one man operation, and the Eaglehawk route, with two man operation. There are 18 motor cars equipped with American Westinghouse motors, and five trailers. The system is 550 volt d.c. with overhead trolley, and the energy consumption during the year ended March 31, 1924, amounted to

be the blade clearances do not alter and therefore the only temperature limits are those that may arise from the physical characteristics of the materials used.

The turbo-alternator cylinder is wholly supported by the condenser, the principal portion of the weight being taken by the exhaust flange. Four spring supports, placed two at each end beneath the alternators transmit the remainder of the weight to the condenser, at the same time allowing for expansion. This arrangement of the machine makes the foundation work very simple. No bed plate is needed but the condenser is supported by means of heavy iron brackets on four small concrete piers. In each

gradient is approximately equal to that through the turbine blades. Thus the steam itself practically neutralises the axial thrust set up between the rotor discs, and relieves the Michell blocks of much of their duty. Whatever steam does leak through the labyrinth is passed with the exhaust to the condenser and the heat recovered in the condensate. The amount thus passing is approximately one pound per hour for every pound per sq. in. of pressure in the steam chests.

The Brush surface condensers are of the counter flow type with solid drawn brass tubes. The auxiliary equipment for each comprises one centrifugal extraction pump, built by the Pul-

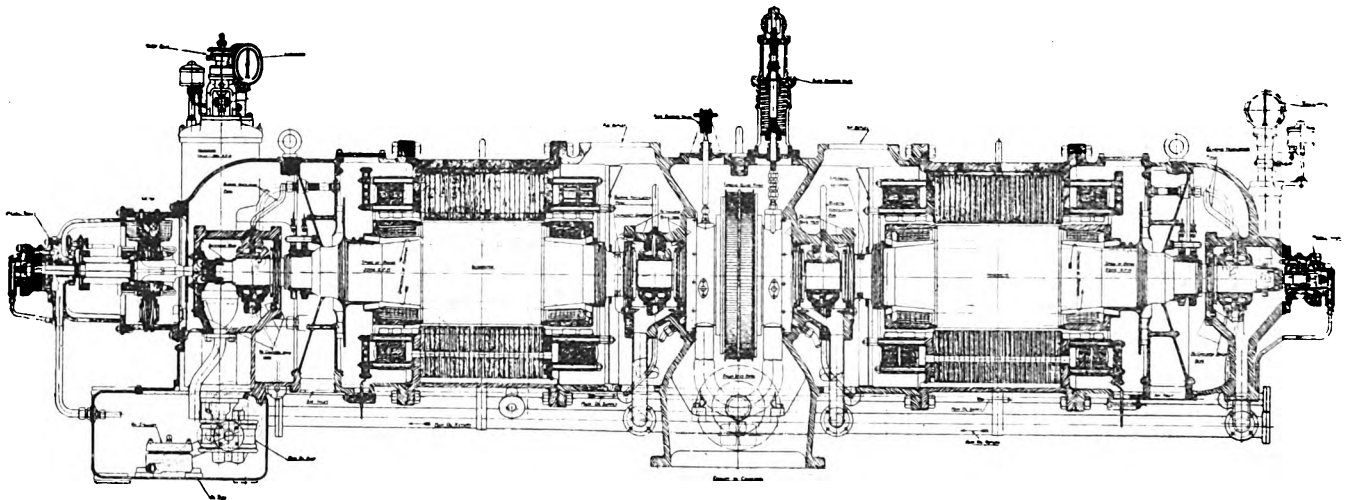


Fig. 6. Section of 1,500 kw. Brush Ljungstrom Turbo-Alternator

of the installations under consideration the piers for the two sets are built on a concrete bed 26 ft. long, 13 ft. wide and 5 ft. thick, in such a position that the sets are at the ends of the bed at right angles to the direction of its length. The concrete is reinforced by steel members in the form of an inverted bridge, which transmit the weight from the ends, giving it an even distribution.

The steam is brought into the two steam chests of the turbine by means of a copper Y piece insulated to prevent escape of heat. From the chests it passes through ports in the rotor hubs and expands radially through 40 blade rings, 20 on each rotor, to the outer casing, passing thence to the condenser. There is no necessity for insulation on the turbine casing, for the steam in contact with it is at the exhaust temperature. Provision for overload is made by two valves, one automatic and one hand operated, which allow some of the high pressure steam to by-pass the first 18 expansions and come into action on the nineteenth blade ring. Special labyrinth discs are arranged between the stationary and the revolving portions of the steam chests to prevent undue escape of steam. These are so arranged that the pressure

someter Co., driven by a Brush d.c. motor, one Brush-Delas air ejector, and a circulating pump of 130,000 gal. per hour capacity, built by Mather and Platt, driven by a 48 h.p. Brush d.c. motor. The Brush-Delas ejector is a particularly efficient piece of apparatus and is thoroughly stable in operation while requiring no attention. It consists of a primary and a secondary jet supplied with high pressure steam, a water cooled diffuser for each jet, and an intermediate jet condenser. The general arrangement is clearly seen in the sectional drawing, Fig. 7.

The air from the main condenser entering at A is compressed in the first stage up to the jet condenser, B, where a stream of water, supplied from the extraction pump discharge, condenses the steam of the first stage. The condensate water and the condensed steam pass through the connection C and return to the main condenser through a water sealed U pipe. The incondensable gases, freed from steam, are drawn in the direction of the arrows F and compressed in the second stage up to D. The steam and extracted air are then led to a surface feed heater through which the main condensate passes, in which the heat is recovered and passed to the hotwell. The condensed steam and

air are then passed to a drain sealing tank, where the air is liberated to atmosphere. The direction of the flow of cooling water for the diffusers is shown by the arrows K. This cooling causes the compression in the diffuser to be almost isothermal and greatly improves the efficiency of the ejector. The small jet condenser between the stages also improves the efficiency, and the combined effect ensures stable operation under varying jet conditions. In

Oil is supplied to the bearings of the set by a forced lubrication system. A gear type pump is used and the pressure at the bearings is maintained between $3\frac{1}{2}$ lb. and 5 lb. per sq. in. A steam driven Worthington oil pump is used for bringing up the oil pressure when starting, but this is shut down as soon as the set comes up to speed. The oil is cooled in a surface cooler using a portion of the circulating water, or alternatively water from the town supply. Cleanliness is ensured by removing and filtering a portion of the oil in the reservoir daily.

The governor is of the spring loaded type, operating a double beat throttle valve through an oil relay supplied from the main system. It is impossible to start the set until the pressure has been brought up to the correct figure by the auxiliary oil pump. There is also an emergency governor which operates to trip the main stop valve if the speed of the set exceeds 10 per cent above normal.

The alternators are very strongly constructed. Each rotor consists of a solid steel forging with milled slots, and is designed for a critical speed of approximately twice normal running speed, thus eliminating all chance of vibration. Axial ventilation is used, the air supply for the two machines being drawn through a single Premier wet air filter, and conveyed by a sheet steel duct system. The air discharge is at the top of each stator end frame. The stator windings are each star connected, and the two machines of a set are permanently paralleled. This arrangement has proved quite satisfactory in practice as the machines synchronise without any trouble. In addition to driving the alternator one turbine rotor drives the exciter, governor and oil pump. Therefore this half of the set has slightly more inertia and friction than the other half, and will be slower in starting. In opening the stop valve for starting it has been found best to admit the steam in a slight puff, so that the impulse might start the heavier rotor more nearly in synchronism with the lighter. When the former comes up to a speed of about 1,300 r.p.m. the exciter commences to generate; the field current will then pull the two rotors into step, and the set comes up to full speed in synchronism.

The performance of the sets since their installation has given complete satisfaction to the operating engineers at both stations. The guaranteed steam consumption on full load was 13.9 lb. per kw. but the actual figure obtained on test was 13.5 lb. without any tolerance allowances. With a load of only 530 kw. the consumption has tested out at 15.5 lb. per kw. On light loads, in the neighborhood of 100 kw., it has been found that the boiler fuel consumption is approximately one half of that when the reciprocating sets were used. The average fuel consumption is about $2\frac{1}{2}$ lb. of coal per unit

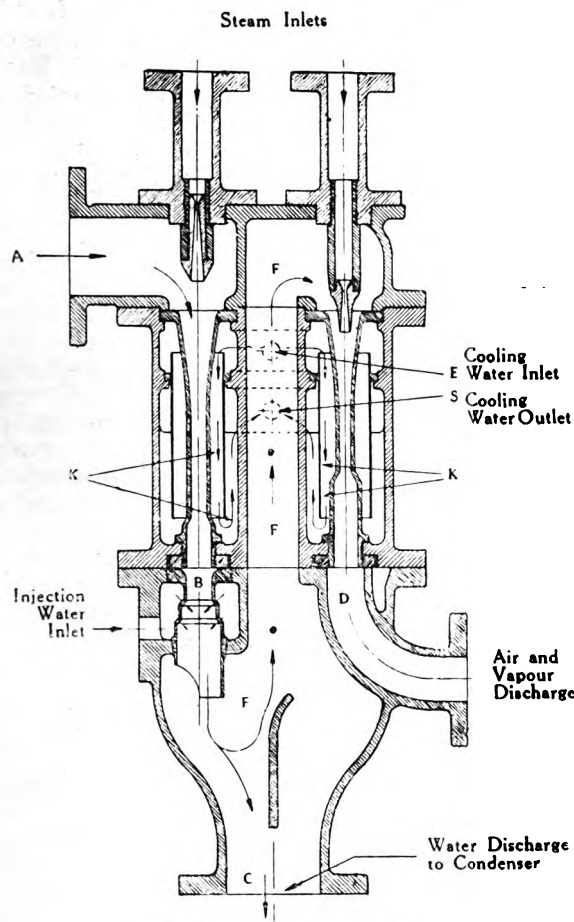


Fig. 7. Brush DeLaval Ejector

addition to its efficiency the apparatus is very simple to start, the only operations being the turning on of the steam jets—the secondary first until the vacuum builds up—and of the cooling water supply.

With this ejector, and with the circulating water under normal conditions, i.e., dropping in temperature about 10 deg. F. in the cooling equipment, the absolute back pressure is readily maintained at about one half pound per sq. in. The power station at Ballarat is about 1,500 ft. above sea level, therefore $28\frac{1}{2}$ in. is a normal barometer. At this figure $27\frac{1}{2}$ in. vacuum is the usual reading. At Bendigo, which is about 600 ft. above sea level, the respective readings are $29\frac{1}{2}$ and $28\frac{1}{2}$ in.

generated, which is an excellent figure when it is considered that the calorific value of the coal is not always particularly high, and that the sets have been seldom more than half loaded. In addition to the halving of the fuel cost the new sets are bringing about marked economies in water, oil, repairs and labor. Under ordinary conditions it is now necessary to run only one boiler where three were formerly required, a second boiler standing by to assist occasionally on peak loads.

On an overload test each set has carried 1,750 kw. with the by-pass not fully open. When this load was thrown off the maximum speed variation was 3.3 per cent, and the final speed 2.5 per cent above the original. The tests have disclosed that, although the sets are only rated at 1,400 kw. at .8 p.f. they can quite readily carry 1,500 kw. as a normal load. The overall electrical efficiency of the alternators, trans-

formers, and rotary converters supplying the present load works out at 91 per cent.

It has been mentioned that the simplicity of the foundation work and ease of erection are strong points in favor of the Brush-Ljungstrom sets. This has been strikingly exemplified in the cases under notice. The order for the four sets was placed in November, 1923. The first set in each station was running in November, 1924, and the second set in each in December, 1924. This is all the more creditable in view of the fact that the excavations for the foundation work were not commenced until March, 1924. The erection of the sets was carried out by the Electric Supply Co. with the assistance of a supervising engineer sent out by the Brush Co. The Brush Electrical Engineering Co. Ltd. has direct representation in Australia, reference to which will be found on another page.

Electrical Plant for Western Australia

The government of Western Australia operates at East Perth the largest electric supply station in the state, providing bulk power supplies for the local authorities of the city of Perth and the surrounding districts. The steadily increasing demand for electric service has brought about an urgent necessity for considerably increasing the capacity of the generating station, and orders have recently been placed for equipment which will increase the station capacity by over 60 per cent.

When considering the tenders for this equipment the government found itself faced with the prospect of paying very heavy duty charges, which amounted to such a figure as to seriously load the whole enterprise, and jeopardise the reasonable price at which power had hitherto been made available. Application was therefore made to the Commonwealth government for remission of the duty. After protracted negotiations the latter authority agreed to this course, excepting an amount of approximately £10,000, the duty payable on a portion of the plant for which an Australian tender had been received. The minister for customs, however, has made it clear that this remission of duty must not be taken as a precedent. The decision was influenced by the considerations that the Western Australian government plant is supplying power to many industries around Perth, which power must be made available at the cheapest possible rates, and that no Australian tenders had been received for the bulk of the plant. By the remission the state government saves approximately £44,000.

The items for which tenders have now been accepted are as follows:—12,500 kw. turbo-alter-

nator, condensing plant, circulating pumps, etc., C. A. Parsons and Co., £46,910; two marine type water-tube boilers, with economisers, mechanical draft plant, coal and ash conveying plant, steam pipes, feed pumps, evaporators and heaters, Babcock and Wilcox Ltd., £91,430; extensions to buildings, Babcock and Wilcox Ltd., £19,700; extra high tension switchgear and control room, Metropolitan-Vickers Electric Co., £11,240; low tension switchgear, Metropolitan-Vickers Electric Co., £4,900; 500 kw. house turbine, station transformers, etc., Metropolitan-Vickers Electric Co., £4,698.

The turbo-alternator is of Messrs. Parsons' latest design, and the turbine exhausts to a surface condenser of ample dimensions, designed for maintaining a high vacuum under the unfavorable cooling water conditions sometimes experienced in the Western Australian climate. Each of the boilers is rated at 65,000 lb. of water per hour at 215 lb. per sq. in. pressure and a temperature of 650 deg. F. Each is capable, however, of being forced to a continuous evaporation of 97,500 lb. per hour, and for short periods to 130,000 lb. per hour. Thus the chief difficulty with which the operators have had to contend in the past, viz., shortage of steam, will be overcome. A considerable time must, of course, elapse before this plant is in running order, and fears have been expressed that in the meantime the city of Perth will suffer somewhat from shortage of power. Careful management, however, should enable the authorities to get through the coming winter without any serious restrictions, providing the present plant stands up to the work.

The Inspiration of Past Achievements

The study of history must always be a matter of vital interest. Whether it be in tracing the social progress of the human race since the earliest indications of civilisation, in following the development of a particular nation through calamities and triumphs, or in studying the unfolding of some branch of art or science, there is a peculiar fascination in the subject. Whence does this arise? It is not in dates, places, names or nations. Personalities may have something to do with it; patriotic sentiment may increase interest; but the vital and compelling point is the great law running through the whole story. That earnest endeavor after a worthy object always in the ultimate, reaps its reward. It is only by viewing occurrences over a distance, standing back as it were, to get the perspective, that this is perceptible; and herein lies the value of the study. History is more than a matter of interest; it is an inspiration and an assurance of success. How often in past ages have idealists and reformers, searchers after truth, struggled to attain to some noble end to benefit their fellow men, fighting against natural difficulties and, oftentimes, the opposition of those they were trying to help? How often have they given their lives, apparently fruitlessly? But the perspective shows that sacrifice is never in vain. No worthy work is allowed to fail; others, inspired by great lives, carry on until the end is accomplished. Thus it is good for us sometimes to turn our attention to a retrospect of the path over which we have been brought to our present status, using it to indicate the possibilities for future advancement. There is a long road between savagery and modern civilisation, and history surely indicates that we have yet far to go. The ultimate goal is as unknown to us, as our present civilisation and science were unknown to our prehistoric forbears.

Having these points in mind let us make a brief review of some outstanding phases in the history of electrical engineering. Professor G. W. O. Howe, in his presidential address to the engineering section of the British Association, at Toronto last August, said, "If any one event can be regarded as the birth of electrical engineering, it is surely the discovery by Faraday in 1821 of the principle of the electro-motor; that is, that a conductor carrying a current in a magnetic field experiences a force tending to move it. It is noteworthy that ten years elapsed before Faraday discovered magneto-electric induction; that is, the principle of the dynamo. Four years later Sturgeon invented the commutator, and in 1845 Cooke and Wheatstone used electromagnets instead of permanent magnets. It was during the years 1865-1873 that

the shunt and series self-excited dynamo finally evolved." Thus, step by step, were the primary principles of dynamo-electric machines brought to light.

The development of incandescent lamps was similarly slow. The earliest attempts were made in 1841, with lamps having spiral platinum filaments; but it was not until 1878 that the commercial development of the incandescent lamp was begun by Edison and Swan. The carbon filament lamp, the earliest form achieving commercial success, held its own for about 20 years, but its displacement began with the invention of the osmium lamp. This was followed later by tantalum and tungsten filament lamps, working up to the present gas filled types.

The realisation of the idea of supplying electric current from a power station for lighting houses in the vicinity owes much to the energy and business ability of Edison. In 1882 he installed two 90 kw., 110 volt, bi-polar steam driven generators at Holborn Viaduct, thus establishing the first central station. Ferranti was apparently the first to suggest that a power station should be situated outside the city supplied, at a point convenient for fuel and water, and that the power should be transmitted by high voltage alternating currents. In 1890 he built the Deptford station for the London Electric Supply Co., installing 1,000 kw., 10,000 volt alternators, and transmitting by underground cables. The pioneer overhead high tension line was built in 1891, and transmitted power at 8,500 volts, three phase, over a distance of 110 miles, from Lauffen to Frankfurt in Germany.

The commercial development of electric traction dates practically from the operation at the Berlin exhibition in 1879 of an electric railway one-third of a mile in length. The first regular traffic line was opened in Berlin in 1881; it worked on the third rail system, at 100 volts. Many difficulties were encountered in the development of electric traction, not the least of which was that of commutation, as the copper brushes originally in use were not suitable for reversing motors. In 1885, however, the carbon brush was invented, and the use of this, coupled with a better understanding of the principles of motor suspension and gearing, resulted in rapid development of electric tramways and railways.

Perhaps the earliest application of electricity was in the transmission of intelligence. There are records of attempts as early as 1746 to use frictional electricity in a form of telegraphy. Although various proposals were put forward from time to time nothing commercial was done until the discovery, in 1819, of the magnetic effect of an electric current. This date really

marks the commencement of the development of practical telegraphy. Many inventions of outstanding importance followed during the next twenty years. Successful communication by land, however, was not sufficient, and the first submarine telegraph cable was laid between Dover and Calais in 1850. It was many years before complete success was achieved in submarine telegraphy, and experience was only gained through heavy losses. The next step in communication was the invention by Bell in 1876 of the telephone, followed by extensive work on the perfecting of exchange systems and of long distance telephony. As is well known, telegraphic communication without the aid of connecting wires owes its commercial development to Marconi, who, after much experiment, succeeded in 1901 in effecting communication across the Atlantic. Other experimenters have followed on, and even in the brief period that radio communication has been in operation many discoveries of a revolutionary character have been made.

So much for the first steps in some of the branches of electrical engineering; turn now to more modern developments. Even during the last ten or twelve years the advances have been truly amazing. In 1913 the largest 3,000 r.p.m. turbo-alternators had an output of 7,500 kw.; to-day such machines are built for 30,000 kw., while 1,500 r.p.m. machines are built up to 60,000 kw. capacity. Turbine unit efficiencies have advanced, with increase in size and refinements in design, from 14.5 per cent in 1903 to 30.5 per cent in 1924, while overall plant efficiencies have been brought up from 9.2 per cent to 21.7 per cent. Rotary converting machinery has been built in ever increasing sizes, both for frequency changing and for conversion from a.c. to d.c. The mercury arc rectifier has been developed to capacities originally thought impossible, and is proving efficient and thoroughly reliable. In the traction field locomotives of ever increasing power are under construction. One of the latest, for the Detroit, Toledo and Ironton railroad weighs 335 tons, is 117 ft. in length and is driven by sixteen 250 h.p. motors. It will operate on a trolley voltage of 22,000 at 25 cycles, the energy being converted to d.c. by motor generator sets.

One of the very latest developments, which as yet is hardly past the experimental stage, is the production of high tension continuous current. The transverter, an arrangement of transformers and rotating brushes, converts three phase a.c. into an almost steady continuous current of high voltage, suitable for transmission over long distances. The machine has the great advantage of reversibility, so that there appears to be a prospect of a swing back to d.c. transmission.

In communication systems the development of automatic telephone exchanges, and the recent

invention of the teletype, whereby messages are sent by means of a keyboard similar to a typewriter and received in type written form, are amongst the outstanding achievements. The advances in radio communication are simply astounding. Since the invention of the three electrode valve many difficulties have entirely disappeared. Amateur experimenters have conversed with one another across half the globe, and commercial radio communication between any two points on the earth's surface is now possible.

These are some of the outstanding advances of electrical science. What do they teach us? First, that stable progress is often slow, and that failure to get immediate results should be no cause for discouragement. Second, that every invention that has resulted in the advancement of the science and industry, and in increased benefit to mankind, has been the result of strenuous toil and painstaking research. Third, that a combination of pure science with ability to make practical applications is essential for progress. Each and every one of these components is necessary for development, but research is the keynote of the whole.

Mr. E. W. Rice, of the General Electric Co., U.S.A., in a paper read before the World Power Conference last July, stressed this point and, in a most interesting manner, drew attention to certain lines upon which research might be carried out for future developments. There is little to complain of in the efficiency of a great deal of the electrical machinery in present use. The losses in transformers and dynamos have been brought down to a very small figure, but there is still room for improvement in other directions. The questions of reduction of weight and cost are always before us. Insulating materials are by no means perfect, and there is always the possibility of the discovery of something better. Finality has not yet been reached in the qualities of the metals used; even now research is disclosing better results in conductivity of copper and permeability of iron.

Our greatest reservoir of energy is fuel, but with all our advances there is still tremendous waste in the conversion of fuel energy into useful work. The most efficient converter, the internal combustion engine, only makes available about 40 per cent of the thermal energy in its fuel, while the steam boiler and turbine converts barely 30 per cent. Sunlight is the great primary source of all power, and there may possibly be a means whereby conversion of energy may be made more directly than through the use of sun energy in the condensed forms of coal, oil or falling water.

Another new field opens with the consideration of direct current high tension transmission. The transverter, mentioned above, has great possibilities. It may be, however, that the most efficient conversion of a.c. to d.c., and vice versa,

will be found in some electronic action, in apparatus developed along the lines of the thermionic valve or mercury arc rectifier.

Scientific investigations into the ultimate nature of matter must be watched very closely, as it appears that we are on the verge of discoveries that may have very far reaching effects upon electrical practice. The influence of atomic structure upon the conductivity or insulating properties of materials offers a fascinating and valuable study.

There is still room for tremendous improvement in what was one of the earliest applications of electrical energy, the production of light. The overall efficiency from coal to light in the early days was so poor that the energy of all but three pounds of the coal per ton was lost as heat in the various stages of transformation. Even now under the best conditions scarcely more than the energy of 50 lb. of coal per ton is actually transformed into light, the lamp efficiency in the very best cases being only eight per cent. It may be that researches into the phenomena of gaseous conduction will lead us to some more efficient method of light production. The efficiency of the glow worm is said to be practically 100 per cent; cannot man discover its secret?

The necessity to the electrical industry of constant research is now widely recognised, and expression has been given to this recognition in many ways. In Great Britain the British Electrical and Allied Industries Research Association has been in existence some four years, and its various sectional committees have done much valuable work. Many of the large electrical manufacturers maintain elaborate research departments. It is striking to notice that an association of three of the largest electrical companies in America spends more on research annually than all the other industries put together. In consequence of such influences each step forward taken by the electrical industry of late years has been the direct result of research, rather than of the trial and error methods which formerly governed progress.

But development in electrical engineering is synonymous with the advancement of the whole human race. Such a state of affairs has arisen during the past century that the task of carrying humanity along the road of progress has fallen almost entirely to the scientist and the engineer. It therefore behoves electrical engineers to maintain every endeavor towards the attainment of their ideals, and to neglect no avenue which might lead to increased knowledge and more useful service.

Early History of Electric Supply in Melbourne*

Although Australia is far distant from those places which have been the chief centres of scientific progress it has always kept fairly well up-to-date in taking advantage of any developments tending to the betterment of living conditions. Electricity can certainly lay claim to a foremost position amongst such developments, and it is therefore interesting to examine records of the early days in the Australian colonies, noting the development of electric supply, and how it has kept pace with progress in the older countries.

Electricity was, of course, at first supplied for lighting only. The first record of electric lighting in Melbourne is a description of a display given in 1863 to celebrate the marriage of the Prince of Wales. The government erected three arc lamps, one at the post office, one at the telegraph office and one at parliament house. Current was generated by means of Cullen chemical batteries, a group of cells being required for each lamp. Owing to the cost of generation, such lighting was suitable only for exhibition purposes. Nothing was done of a commercial value until 1878 and 1879, when

Sands and McDougall and the Apollo Candle Co. each imported an arc lamp and dynamo outfit. Although lighting by this means was not so costly as the original attempt it was not a great success, principally owing to the glare of the unprotected light source then in use.

The first attempt to form an electric lighting company appears to have been made early in 1880, but it did not get past the prospective stage. In October of the same year, however, the Victorian Electric Co. was formed with a nominal capital of £2,500. A workshop and the nucleus of a central station were laid down in Russell lane, off Bourke street. One of the first contracts carried out was the lighting of the Eastern market. This was not supplied from the central station, but by means of a portable steam engine erected on the premises, belted to a countershaft which drove about a dozen Weston dynamos, each machine supplying one arc light. The company soon found that its capital was too small, and in 1881 it was taken over by the Australian Electric Co. with a capital of £100,000.

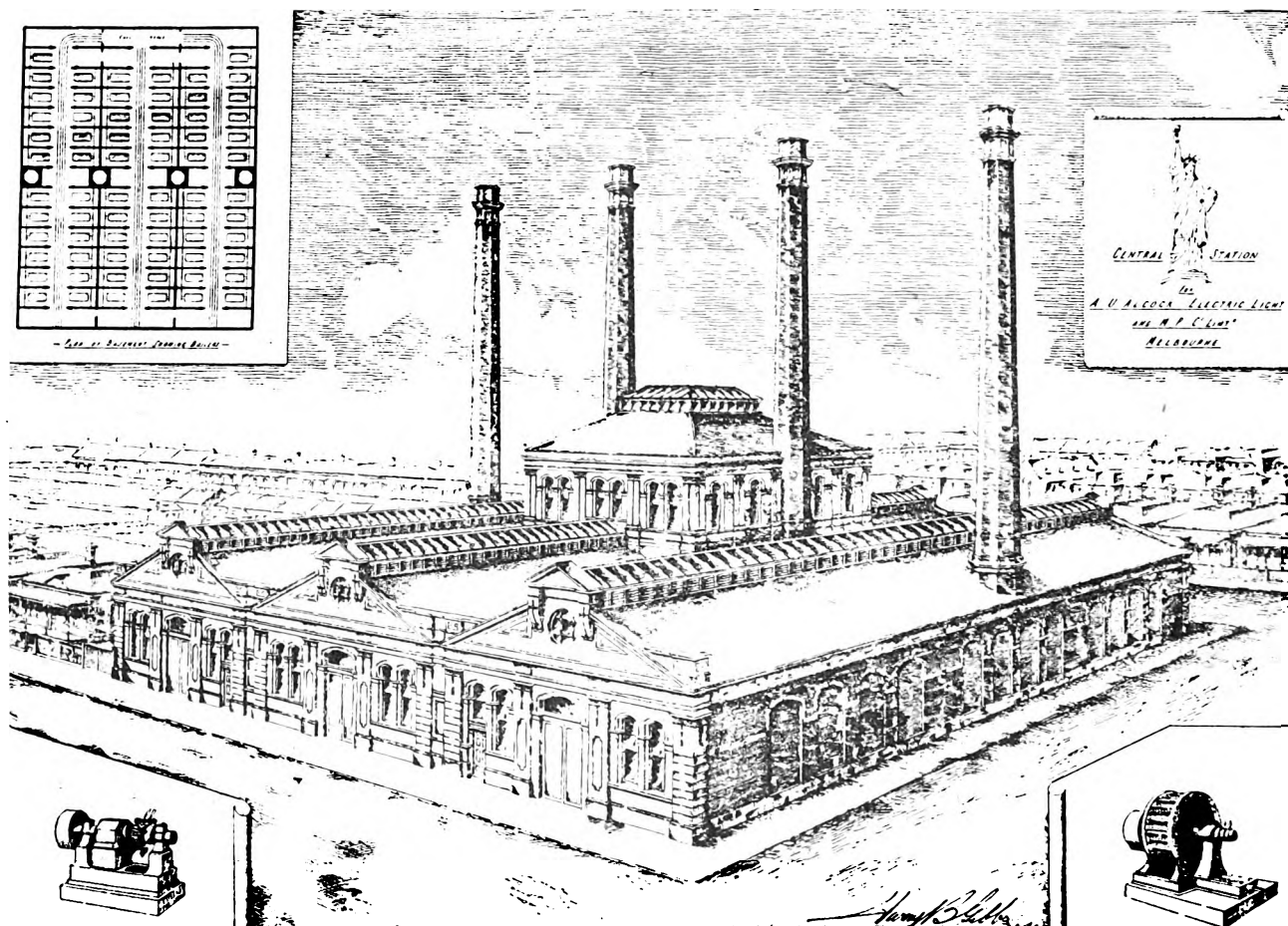
The introduction, by Edison and Swan, of carbon filament incandescent lamps made pos-

*In the compilation of this article, a paper written by Mr. A. U. Alcock in 1906 has been one of the principal sources of information.

sible the supply of electricity for general lighting. In 1882 the Athenaeum hall was lit by these lamps, the current being supplied from the Russell lane station. The auditorium of the Opera House was next illuminated by the same means, 120-20 c.p. lamps being used. A little later electric lighting was installed throughout the whole theatre, a proceeding

ment house, but the original company ultimately obtained it. The Australian Electric Light, Power and Storage Co. merged a little later with the Australian Electric Co., and the Edison Co. withdrew altogether.

At about this time the Spencer street railway station was lighted with Brush arc lamps. Most of the larger lighting installations around



Proposed Power Station for the A. U. Alcock Electric Light and M.P. Co. Ltd., 1890

which involved the use of about 600 lamps. With the load increasing the Australian Electric Co's plant was added to until it was capable of supplying about 1,500 incandescent lamps and 30 arc lamps.

In the year 1883 two competitors put in an appearance, the Australian Electric Light, Power and Storage Co., and the Indian and Colonial Edison Co. The former company lit Elizabeth street from Flinders street to Victoria street by means of 16 Brush arc lamps, but although the experiment was quite a success from the engineering standpoint the cost did not altogether meet with the approval of the city council, so there were no extensions. Great efforts were made by each of these three companies to secure the contract for the lighting of parlia-

ment house, but the original company ultimately obtained it. The Australian Electric Light, Power and Storage Co. merged a little later with the Australian Electric Co., and the Edison Co. withdrew altogether. At about this time the Spencer street railway station was lighted with Brush arc lamps. Most of the larger lighting installations around the city were supplied from isolated plants as, owing to the low generating voltages in use (50 to 100 volts), it was not economical to transmit over any distance. Thus, in addition to the plants already mentioned, there were generating sets at the public library, post office, parliament house and Princess theatre, all installed by the Australian Electric Co. In the year 1888, however, the alternating current high tension transformer system of Messrs. Ganz and Co. gave a great impulse to electric lighting. The Australian Electric Co. purchased a Ganz plant having a capacity of 3,000 lights, and immediately set about dispensing with the isolated plants and supplying from the central station.

In the same year Mr. A. U. Alcock inaugurated a small station in Corr's lane, off Little

Bourke street, introducing the Woods series arc light system. The generator was of the Gramme type and had a special feature for maintaining constant current. This consisted of a solenoid operating a friction wheel geared to an armature spindle which moved the brushes around the commutator as the number of lights in circuit was varied. The generator supplied 35 lamps of 2,000 c.p. each, with a pressure of 50 volts across the lamp terminals. At about the same period also Messrs. Masters and Draper introduced the Thomson-Houston arc light system, which was ultimately adopted by the city council for street lighting.

Towards the end of 1888 the Australian Electric Co. reconstructed under the name of the New Australian Electric Light Co. with capital of £250,000. A piece of land was acquired at Richmond, the site of the present Melbourne Electric Supply Co. station, and work commenced on a new power house, planned for an ultimate capacity of 12,000 h.p. The first section of the plant was put into service in 1890, and comprised three 330 h.p. Robey engines each rope driving a 2,000 volt 96 cycle Lowrie-Parker alternator. Provision was also made for installing two 130 h.p. Austral Otis engines, each driving a line of shafting to which was belted an alternator having a capacity of 1,000-10 c.p. lamps and two Thomson-Houston generators of 30 arc lamp capacity. Steam was supplied to all the engines from two 250 h.p. Babcock and Wilcox boilers.

In 1888 the largest electric lighting scheme that had been attempted in Australia was put in hand. This was the illumination of the Centennial Exhibition, which was carried out under the direction of Mr. K. L. Murray, then chief of the telegraph department of the Victorian railways. The lighting units comprised 1,000 arc lamps, 3,000-16 c.p. incandescent lamps, and 40-400 c.p. "sunbeams." These were supplied from 16 Brush arc lighters and Victoria Mordey generators driven by locally built engines and boilers. The installation was very successful.

In 1889 Mr. Alcock's station, which had been extended by the addition of a Ganz high tension system with a capacity of 700-16 c.p. lamps and another 35 lamp Woods arc lighting dynamo, was taken over by a company formed for the purpose, with a capital of £100,000. This company installed a small station in South Melbourne, to cater for local requirements, and set about making plans for the erection of a large station in Richmond. About the same time another concern, the Union Electric Co. commenced operations with a small station in Hefernan lane off Little Bourke street.

This period was evidently one of great activity in electric supply matters. Amongst other information it is recorded that an exhibition of electric cooking was given on August

22, 1890, but nothing is said regarding the success or otherwise of the experiment. Also in this year the Fire Underwriters' Association issued the first compilation of rules and regulations governing electric lighting installations. All was not smooth running, however, for it is recorded that in the same year the New Australian Electric Lighting Co. suffered serious loss through a fire at its Russell lane station. It is also stated that strikes caused a considerable increase in the price of coal.

In 1891 the New Australian Electric Lighting Co. secured contracts for street lighting in Richmond and Prahran at £5 per lamp per annum. About this time the Melbourne city council took up the question of electric lighting and appointed Mr. A. J. Arnot, of the Union Electric Co., the first city electrical engineer. In May of the same year the postal department installed a generating plant comprising two 16 h.p. engines driving four Victoria Mordey generators and a 26 light Brush arc generator. Two of the generators were manufactured locally by the New Australian Electric Light Co.

In October, 1891, the first section of the generating station planned by the A. U. Alcock Electric Light and Motive Power Co. was opened. The station was situated in Burnley street, Richmond, and the plant comprised three multitubular boilers manufactured by the Langlands Foundry Co. of South Melbourne, two pairs of Wright and Edwards steam engines, four 80 kw. Ganz alternators generating at 2,000 volts 42 cycles, and five Woods series arc generators. The switchboard was designed to carry eight generators running in parallel, and a bank of 1,000-16 c.p. lamps was installed to provide an artificial load to assist in paralleling the alternators. The illustration shows that the station was designed on rather extensive lines. It was built over a quarry hole which had earned an unenviable reputation in respect to suicides and accidental drownings, but which was very useful to the electric supply company, as the boilers were erected in the basement. An extract from the Building and Engineering Journal of Dec. 27, 1890, gives an idea of the nature of the whole enterprise:

"The quarry hole situated in Burnley street, Richmond (Vic.), which for years past has been a source of annoyance to the Richmond City Council, has lately been purchased by the A. U. Alcock Electric Light and Motive Power Company Limited, upon which they have commenced to erect the first section of a central station to supply the city and suburbs with electricity.

"The building will cover an area of about 1½ acres, and consists of the basement storey (20 ft. high), to contain 60 boilers and workshops, with four large chimney stacks, each 155 ft. high. Under this floor at one end will be an immense tank (64 ft. x 20 ft. and 25 ft. deep) for the storage of water, and above will be the

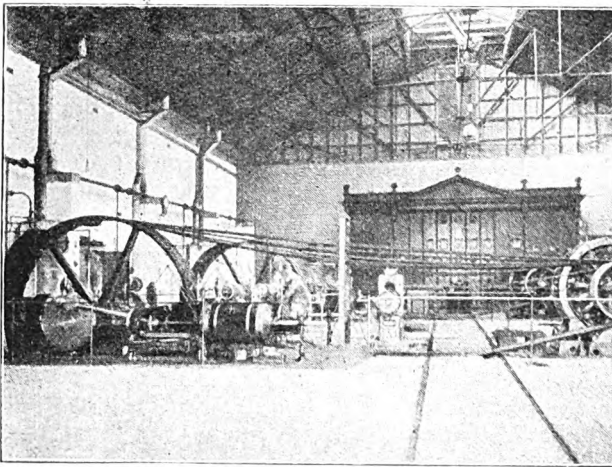
coal bin, from which the fuel is conveyed by trucks and tramway through each section.

"The ground floor (20 ft. high) is constructed of a network of girders and fireproof flooring, and will be reserved for the engines, dynamos, etc. All the wires will be collected in the switch-room, forming the third storey (64 ft. x 70 ft.) in the centre of the block, and from this point all currents will be regulated.

"The building will be constructed of ornamental brickwork in cement girders and ironwork covered in three spans of 64 ft. each by 250 ft. long, and lighted from the roof.

"The company was first started as a private enterprise by Mr. A. U. Alcock, and was formed

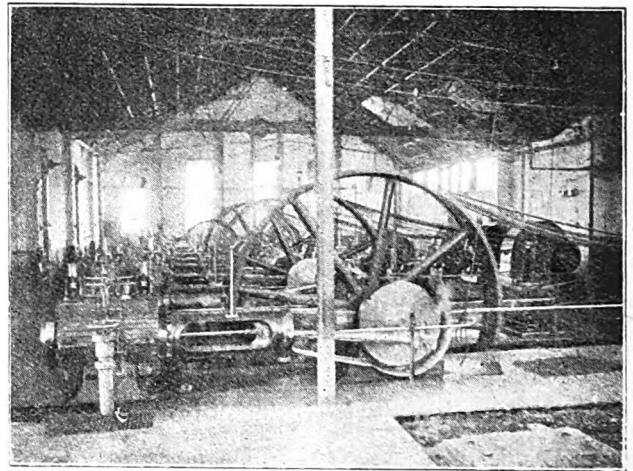
While this construction was going on the city council was beginning to make headway. A scheme for city lighting, estimated to cost £75,000, was submitted and tenders were called for engines, boilers, 15 generators, 633 arc lamps, 1,200 incandescent lamps, four switch-boards and sundry details. The contracts were finally awarded to Messrs. Babcock and Wilcox for boilers, Austral Otis Co. for engines, and Thomson-Houston International Electric Co. for generators. The installation was completed and current switched on in March, 1894. During the next few years the council laid down plant for supplying private consumers, and it ultimately purchased the undertakings which had been operated by the various companies in the city



A. U. Alcock E.L. and M.P. Co. Engine Room in 1901

into a company in September, 1889; Mr. W. J. Mountain, M.L.A., being elected chairman. The object of the company is not merely to provide light, but to supply electric motive power by meter. The station when completed will supply about 250,000 incandescent lamps, and the portion now being erected will contain machinery equal to the supply of 20,000. This machinery is now ready, the engines having been manufactured by Messrs. Wright and Edwards; the boiler by the Langlands Foundry Company, and the whole of the electric machinery by Messrs. Ganz and Co., of Buda-Pesth. Wood's patent arc light is used by the company. We purpose giving a full description of the plant when it is in operation. Mr. F. M. Bate is the contractor for the portion of the building now in course of erection, the amount of the contract being £8,000, exclusive of excavations.

"When completed and fitted with the necessary machinery the station will be the largest in the Southern Hemisphere. It is estimated to cost over £250,000, and has been entrusted to Mr. Harry B. Gibbs, F.R.V.I.A., architect, Tuckett Chambers, Collins street."



Electric Lighting and Traction Co. of Aust. Ltd. Engine Room in 1902

boundaries, and which in the meantime had been taken over by the Electric Lighting and Traction Co. of Australia Ltd.

The last named concern, now known as the Melbourne Electric Supply Co. was formed in 1899 to purchase the undertakings of the New Australian Electric Co. and the A. U. Alcock Electric Light and Motive Power Co. The transfer was completed in 1901 and the plant set up by the last named company closed down, all generation being concentrated at the site of the New Australian Electric Co's station. The section of the power station building erected by the A. U. Alcock Co. now forms part of the works of Weymouth's Ltd., electrical engineers.

A further electric supply authority, the North Melbourne Electric Tramways and Lighting Co. Ltd., was formed in 1905, to supply electricity in Essendon, Flemington and Kensington. This brings us down to modern conditions. The three undertakings have continued to supply the electrical demands of the metropolis for many years, the railway lighting station also operating to supply the railway requirements and certain public buildings. The demand has considerably increased, old plant has given place to new,

bulk supplies to various suburbs have been inaugurated. The electrification of the railways has necessitated the erection of another large station at Newport. In the meantime the whole nature of the electric supply business has changed. Whereas it was originally necessary to have a separate plant for each building supplied, modern practice puts the power station 100 miles from the load centre. The electricity commission has been formed and supplies a large part of the city's requirements from its Yallourn power station. The North Melbourne

undertaking has been bought out, and in its place the commission gives a bulk supply. Both the city council and the Melbourne Electric Supply Co. are purchasing a large portion of their requirements in bulk from the Yallourn and Newport B power stations of the electricity commission. The total generating capacity supplying the city's lighting, power, tramways and railways is now in the neighborhood of 190,000 kw. Will the progress of the next 50 years be as amazing as that which has just been reviewed?

Submarine Telephone Cables—II

By M. C. Timms.

Coil Loaded Cables

A method of embodying suitable inductance coils in a submarine cable having been developed by Messrs. Siemens Bros. and Co. Ltd., the British post office ordered from this firm the second channel telephone cable in 1910. Messrs. Siemens were responsible for both the manufacture of this cable and its submersion, which were successfully carried out. For a full description of the cable and the operations reference should be made to the Journal of the Institution of Electrical Engineers, Vol. 46.

The core of the 1910 cable was composed of 130 lb. copper and 300 lb. GP per naut, being identical with that of the first channel cable of 1891. The reason for the choice of this core, which was not left to the contractor, was that should the coils prove unsuccessful they could be cut out. The cable spliced up again would at least equal in transmitting qualities that of 1891. The 1910 cable contains four cores of the weight already indicated, the cross section being identical with that shown in Fig. 3; its length is 21 nautical miles. Speech tests carried out with long lengths of land line coupled to this cable demonstrated the advantages of added self-induction, and the range of telephone communication between towns in England and France was very greatly extended. The electrical constants of the 1910 cable are given with others in Table 1.

Events having proved that any misgivings regarding the successful submersion of a coil loaded cable in moderate depths of water were ill-founded, a number of further cables of similar design were manufactured and laid during the next few years by Messrs. Siemens Bros. and Co. Ltd. to the order of the British post office and other authorities. Those immediately following the channel cable were the Anglo-Belgian (1911), 50 nauts, and the Anglo-Irish (1913), 64 nauts.

All the cables subsequent to 1910 were, however, constructed on economical designs, con-

sonant with the advantages of loading, and the weight of GP reduced to 150 lb. per naut. As a result of this economy, the electrostatic capacity was increased to 0.157 m.f.d. per naut loop. The attenuation co-efficient for the cables mentioned was, however, by means described later, kept at a very moderate figure, as will be seen in Table 1.

The 1910 cable, having four cores, provided two lines. It was not, however, practicable to operate a superimposed circuit on this cable, only two inductance coils, viz., one for each pair of cores, being provided in each set. The later cables, on the contrary, were designed to be operated with superimposed circuits; that is to say, in addition to the two physical circuits, a phantom circuit can be used. In order to load the phantom circuit, it becomes necessary to insert an extra coil in each group. Thus subsequent cables carried three coils per group instead of two, as in the first cable. So that the phantom circuit shall have a proportionate amount of loading, the third coil is designed to have half the inductance and resistance of either of the other two coils.

Loading Coils

The loading or inductance coil herein referred to consists of an annular core of specially selected soft iron. On the core is placed a double winding having a sufficient number of turns to give the desired inductance (100 m.h.) with the minimum resistance practicable ($r = 2.25$ ohms). By making the winding double, the two wires A and B have each one-half the total value on the same iron core. By this means a mutual induction of the two halves of the circuit is added to the self-induction, and a more efficient coil results. The cores of the cable are connected up to the windings in such a way that their magnetic effect is cumulative.

From the point of view, however, of the phantom circuit, the two windings in any core are in parallel, and therefore they neutralise each other's effects, and as far as they are con-

cerned the phantom circuit is unloaded. For this reason, where superimposed working is desired, the third coil is added to each group. This coil has four windings, each connected to a core of the cable in such a way that the flux caused by A and B in parallel is added to that caused by A' and B' in parallel, with the result that no inductance is introduced in the circuit A and B alone or in A' B', while the full inductive effect is available on a circuit composed of A B with A' B' as a return. By this means no further loading is added to the physical circuits, although, however, the resistance of half the third coil is added to each of them.

sorted in the spaces left, and these, as the diameter decreases, at each end of the coils, gradually overrun the main wires of the cable, and form an extra sheath for some distance on each side. They are securely served down, and the whole forms a strong but flexible splice. The coil section is about 3 ft. 6 in. long and $3\frac{1}{2}$ in. diameter, and its insertion in the cable causes a swelling in the latter, increasing the diameter from 2.45 in. to 4.25 in. for a length of about 6 ft. The total length of each coil splice is about 50 ft.

Having made slight modifications in the paying out machine, and by taking special pre-

Table I.

Title or Location	Date	Core lbs. per Naut		G.P.	$\frac{r}{L}$ 800	$\frac{G}{K}$	R_0 ohms	R800 ohms	Per Naut			Remarks
		Nauts	Copper						K m.f.d.	L mho	α	
Dover-Calais	1891	21	160	300	—	—	14.2	14.2	.138	2.0	.047	Not loaded
"	1910	21	160	300	60	120	14.2	14.2	.138	102	.0166	1st Coil loaded
" (T)	1911	23.4	300	300	—	109	8.0	8.53	.176	13.5	.0185	Continuous loaded
Victoria-Vancouver	(H) 1913	28.3	300	300	—	—	8.0	8.5	.17	13.0	.019	do.
Anglo-Belgian	1911	47.9	160	150	60	12	14.2	14.2	.157	102	.0177	Coil loaded
Anglo-Irish	1913	63.4	160	150	48	15	14.2	14.2	.166	102	.015	do.
Norwegian	1920	245	—	—	—	—	—	—	—	—	.0126	Two core continuous loaded
Swedish	1920	73	—	—	—	—	—	—	—	—	.0108	Coil loaded
Danish	1920	59	—	—	—	—	—	—	—	—	.016	do.
Anglo-Dutch	1922	85	—	—	—	—	—	—	—	—	.013	do.
Ireland-Scotland	1922	28	—	—	—	—	—	—	—	—	.016	do.
Nova Scotia-Cape Breton Is.	1923	—	—	—	—	—	—	—	—	—	—	—
Anglo-Dutch	1924	86	—	—	—	25	—	16.12	0.11	19.3	.0199	Paper, lead cased
New Zealand (Cook Strait)	1925	35	—	—	—	—	—	—	—	—	—	Continuous loaded
												Not yet laid March, 1925

All the above cables were manufactured by Siemens Bros. and Co. Ltd., with the exception of T, which was manufactured by the Telegraph Construction Co., and H, which was manufactured by W. T. Henley's Telegraph Works. Co.

The insulating material of the coil windings being of an absorbent nature, each coil is wrapped in tinfoil to prevent the absorption of natural moisture, which would lower the insulation of the turns from the GP envelope. A group of coils being assembled, the ends of the GP insulated cores of the cable are connected up to them. Each pair of cores passes through the centre of the coil to which they are not connected. The whole is then encased in a GP tube, large enough in diameter (about 3 in.) to cover the coils. At each end is fitted a tapered piece, reducing the tube down to the diameter of the assembled four cores, which are made solid at the point where the taper commences. A set of coils thus enclosed in GP has been subjected to hydraulic pressure of four tons per square inch without being destroyed. As the diameter of the coil envelope is considerably greater than that of the four cores, the sheathing wires of the cable will not completely cover it. Extra wires are therefore in-

cautions whenever a coil passed over the sheaves, the contractors experienced no difficulties when laying the cable. It has since been demonstrated that such a cable can be safely picked up for repair from the moderate depths in which it has been laid.

Improved Dielectric

Examination of formula 5 discloses that the value of G/K has a very important bearing on the performance of a loaded telephone line. This fact was brought home by experience on the first loaded aerial lines in the United States, where it was found necessary to replace glass insulators by those of porcelain, in order to get the full benefit of loading. Glass, though in itself an almost perfect insulator, is much more prone to become leaky through surface moisture than porcelain.

With the Anglo-Belgian cable of 1911, Messrs. Siemens Bros. and Co. Ltd. initiated the use of balata as a substitute for ordinary gutta percha. The reason for the innovation is the reduction

so obtained in the value of G/K. Balata, which is a substance akin to gutta percha, was for many years regarded as not suitable for insulating purposes. As a result of experiments, however, Messrs. Siemens concluded that it could be so prepared that for telephone purposes it would be superior to gutta percha. The use of this substance as a dielectric has been patented and applied by this firm in many important telephone cables, resulting in improved performance. For balata G/K is less than 20, as contrasted with 120 for GP.

By the use of this improved dielectric, the characteristics of the Anglo-Belgian, Anglo-Irish and other cables all having cores 160/150 are practically as good as those of the 1910 Channel cable with a core of 160/300. These characteristics are accompanied by a very considerable saving in expenditure.

Continuous Loaded Cables

A cable loaded by the simple device of a whipping of soft iron wire around the conductor under the dielectric, while having electrical characteristics, if less advantageous than coil loaded cable, still much superior to a cable having no loadance, is mechanically considered identical with the ordinary telegraph cable, which in design has behind it the experience of over half a century.

As has been stated, at the time of the first loaded Channel cable, there was in certain quarters considerable doubt as to whether a cable embodying inductance coils could be safely submerged in the comparatively shallow waters of the English Channel. Further, it was doubted whether, having been laid, such a cable could be maintained in effective condition at anything but prohibitive cost. For these reasons the French Channel cable of 1911 was of the continuous loaded type.

It was only found possible when designing the last mentioned cable to obtain about 13½ m.h. per naut loop, and in order to bring the attenuation co-efficient to something approximating that of the coil loaded cable laid in the previous year 300 lb. of copper and 300 lb. of gutta percha per naut were required. This cable was manufactured and laid by the Telegraph Construction and Maintenance Co.

In another instance continuous loading was adopted in preference to the coil system for much more adequate reasons. In the straits which separate Vancouver Island from the mainland of British Columbia, there are encountered depths of water of over 200 fathoms. It was considered by the British Columbia Telephone Co. that in this instance the mechanical features must take precedence, and a continuous loaded cable was adopted. The extra cost over and above that of a cable of the coil type was considered justifiable under the circumstances.

This cable was manufactured and laid by Messrs. W. T. Henleys Telegraph Works Co. in

1913. It contains four cores, and is in general very similar in design to Fig. 3. Each core is constituted as follows:—

- (a) Copper 300 lb. per naut; a special strand having a total diameter of .139 in.
- (b) A layer of soft iron wire .012 in. diameter closely wrapped round the copper making 70 turns per inch, bringing the diameter (d) up to .163 in.
- (c) GP to the extent of 300 lb. per naut, bringing the diameter of the core (D) up to .414 in.

The capacity of a circular core being inversely proportional to log. D/d, it will be seen that as d is increased from .139 to .163 by the addition of the iron wire, K will also be increased. As a matter of fact, the core under discussion has a capacity of .17 m.f.d. per naut loop, whereas an unloaded core having the same weights of copper and GP would have a capacity of .15 m.f.d. By the addition of the layer of iron wire, the inductance per naut loop was brought up to about 13 m.h., and as a result the attenuation co-efficient was reduced to .019 per naut loop. The length of the cable is 26.3 nauts. The French Channel cable of 1911 was almost identical in design with the cable just described.

Consideration of the figures given in the last example will disclose that, in order to obtain transmission characteristics by continuous loading, which are approximately equal to those obtained by coil loading, a very much greater expenditure of material and resulting cost is necessary. Or conversely if a core of moderate dimensions must be adopted for economic reasons much poorer transmission properties have to be contended with. For example, a core composed of 107/150 having a layer of iron wire wrapped round the conductor would have an attenuation co-efficient approximately .053, whereas by coil loading such a core this figure could be brought down to .02. The attenuation co-efficient for a core of this weight entirely unloaded would be .081.

The continuous loaded cable, as has been pointed out, possesses no special mechanical features. It can be handled just as an ordinary telegraph cable, and it involves no extra risk when laid in deep water. Repairing such a cable presents no special features. With a four core cable having continuous loading, loadance for the phantom circuit is automatically provided in the correct proportions without the addition of any special device.

Telephonic Repeaters

The perfecting of the thermionic tube as a telephone repeater has exercised a profound influence on the design of telephone transmission circuits. As has been before indicated, the transmitting qualities of any portion of such a circuit are considered to be inversely proportional to their equivalent in standard cable.

Thus a piece of apparatus which is equivalent to 10 miles of S.C. is considered twice as efficient as a similar piece of apparatus which is equivalent to 20 miles of S.C. A repeater or relay when correctly operating has an effect which from the transmission point of view in terms of standard cable is negative; thus such a repeater has an approximate value of minus 15 miles of S.C.

Having at hand a device which to this extent is capable of making good the losses arising in transmission, it is obvious that a greater amount of such loss can be allowed than was the case when no such device was available. That is to say, transmission lines and cables may be allowed a greater equivalent in S.C. than was previously permissible, hence the attenuation co-efficient may be allowed greater magnitude. For this reason, whereas it was desirable in submarine cables of any length to reduce the attenuation co-efficient to .02 per naut or less, something like double this value may now be permitted. By this means the limitations of continuous loading referred to above have been to a great extent eliminated, and the advantages of this system, as also referred to, now give it in a general way preference over coil loading.

Single Core Cables

On account of their weight, four core cables are impracticable in really deep water. This feature forms a distinct drawback when telephonic connections between certain points have to be considered. A single core continuous loaded cable can be laid in the deepest known waters, and thus the use of such cables for telephonic transmission is worthy of consideration. Examination of curve B in Fig. 1 shows the calculated effect of adding inductance to the extent of 100 m.h. per naut to a long single core submarine cable. The attenuation is there shown to be enormously less than is the case with the same cable unloaded (curve A).

The addition of inductance to an ordinary submarine telegraph cable will have beneficial effects so far as speed of signalling is concerned. Owing to the fact, however, that telegraphic signals are not periodic in nature, it is very difficult to decide on a standard or typical value for f , such that the value of $2\pi f$ could be of the same utility in telegraphic calculations as the figure $2\pi f = 5,000$ is in telephonic calculations. For this reason it is difficult to forecast the result of embodying a certain amount of self-induction in a telegraph cable. Loaded telegraph cables have, however, been designed and laid, notably the Western Union Telegraph Co.'s New York to the Azores cable laid in 1924. At the time of writing we are not in possession of any figures regarding this cable either of design or operation. There is no doubt, however, that it will be successful in so much as the speed of signalling will be greatly increased without a

proportional expenditure on copper and gutta percha. It has been announced in the public press that the duplications of the British Pacific cable, Fiji to Fanning Island, Fanning to Bamfield, B.C., are to be of the loaded type also.

Single core telephone cables are already in operation. From the telephone point of view, the main objection to anything in the nature of an earth return is that by such means a path is provided for vibratory and other currents, strays from power systems, to enter the telephones, thus frequently making speech impossible. In regions remote from power supply systems, this objection ceases to have any weight. The most notable example of such cables are those laid between Key West, Florida and Havana, Cuba. There are three cables, each 105 nauts in length. They were manufactured and laid by the Telegraph Construction and Maintenance Co., and their characteristics and construction are as follow:—

- A. Copper 350 lb. per naut.
- B. Wrapped with soft iron wire, .008 in. dia., 120 turns per in.
- C. Insulated with gutta percha.
- D. Wrapped with a triple layer of copper tape.

The constants of these cables have been obtained experimentally at 1,000 p.p.s., and are as follows:

- Resistance, 3.32 ohms per naut.
- Inductance, 4.35 m.h. per naut.
- Capacity, 0.315 m.f.d. per naut.

Leakance, 12.8×10^{-6} mho per naut.

Each cable is equivalent to 21 miles of standard cable.

One of the difficulties in calculating the inductance and forecasting the consequent performance of a single core cable is that there is some uncertainty as to what path is followed by the return current. The wrapping of copper tape, referred to above, was added to ensure that the bulk of the return current followed a path close to the exterior surface of the core.

It has been stated that the main objection to the use of an earthed return in telephonic transmission is that disturbances from electric power systems obtain access to the telephones. In the case of a long single telephone cable, landing at some point not remote from a power system, such as New York, Sydney or Melbourne, by making the first two or three nauts a two core cable, and connecting one of the cores to the earthed sheath at that distance from the landing place, disturbances from power systems can be eliminated. Preferably the copper sheath should not commence until the single portion of the cable is reached. The cores of the two core cable would most probably be brass taped for protection against teredos in shallow water. The device of a two core shore end is always adopted in telegraph cables landing at such locations.

Latest Developments

The well-known air space paper insulated cable is an ideal medium for telephonic transmission. With the exception of comparatively short lengths in shallow water, crossing river estuaries or narrow waterways, such as the Bosphorus, such cables have not been hitherto employed for submarine work. There are several contributory reasons why this type of cable has not been used at sea. The first is that of excessive weight, but in very moderate depths this forms only a minor objection. By far the most serious objection has been the difficulty of constructing a paper insulated lead covered cable in lengths of more than several hundred yards, and as joints in such a cable made at sea are almost impossible, this has been hitherto an insurmountable obstacle.

Owing to the rapid increase in the density of telephone traffic between Britain and the Continent, it recently became necessary to materially increase the number of circuits available. The ordinary four core gutta percha cable, which is almost the largest practicable, provides only a very limited number of channels. It was therefore decided by the British post office to adopt a paper insulated air space construction, using continuous loading, and a cable 86 nautical miles in length, was ordered from Messrs. Siemens Bros. and Co. Ltd. last year. The cable is constructed as follows:—

- A. Sixteen conductors consisting of four sets of quadruple cores, each conductor having a continuous wrapping of soft iron wire.
- B. Insulated with dry paper.
- C. Two lead casings having a bituminous composition between them.
- D. The usual protective serving, and sheathed with 24 galvanised iron wires of heavy gauge.

The cable was manufactured in ten nautical lengths, without a joint. Obviously such a length of cable could not be put on to a drum, so that after receiving the lead case, the cable was laid down in coils on the floor of the shop. Each ten mile coil was then led through the sheathing machine, and being now armored and capable of standing more or less rough handling, it was hauled away to the tanks. The several ten mile lengths were spliced together and coiled down in the tanks of the cable laying vessel.

In order to cope with such unprecedented lengths of lead covered cable, the manufacturers put down a special plant, arranged with a view to handling long continuous lengths in the lead cased stage. It will be recognised that very special plant and organisation were necessary to accomplish a task of so much greater magnitude than any yet undertaken in this sphere. This cable, manufactured under the ordinary

conditions, in lengths of perhaps a quarter mile, would have contained between three and four hundred joints; as it was, only eight joints were needed. The cable, weighing 2,150 tons, was shipped by the C.S. "Faraday," and laid by Messrs. Siemens on August 29, 1924, the whole operation being carried out without the necessity of making a splice.

Tests after manufacture show the electrical constants of the physical circuits of this cable to be as follows:—

- Resistance, 16.12 ohms.
- Inductance, 19.3 m.h.
- Capacity, 0.11 m.f.d.
- Leakance, 2.8×10^{-6} mhos.
- Att. constant, 0.0199.

All the above are taken per nautical mile loop at 60 deg. F. with 800 p.p.s. The Transmission Equivalent for the full length therefore is 16.1.

The specification included very stringent clauses regarding interference between circuits, and the tests made for cross talk and overhearing, both between physical and phantom circuits, showed the results to be well within the limits set by the specification. The manufacture and laying of this cable may be regarded as an achievement, and it forms a milestone in telephonic progress. Descriptive articles with illustrations may be found in the "Electrician" and "Electrical Review" for September 5 and 12, 1924, respectively.

(Concluded)

Errata

In the first part of this article, in the March number, p. 452, the formula for attenuation should read:—

$$\frac{\text{Received current}}{\text{Sent current}} = \frac{Cr}{C_0} = e^{-al}$$

Where $e = 2.72$
 l = Length of Cable.
 a = Attenuation constant.

SWEDISH TRANSFORMERS FOR VICTORIA

The Victorian electricity commission has recently placed an order with a Swedish firm for the supply of 90 transformers of various capacities for use in its distribution systems throughout the state. Some 15 tenders were received in connection with the contract. The lowest Australian tender was £21,460, while the price at which the Swedish tender was accepted was £15,161, which figure included the duty of 37½ per cent. The general policy of the commission is to give preference to Australian manufacturers, but in this case the commissioners felt that the difference of price was so great that such a course could hardly be justified.

The Regulation of Alternating Current Generators

Determination from Test Data.

By W. H. Gregory.*

The regulation of alternating current generators depends not only on the load but on the power factor of the load, so that it is usual for the regulation to be stated at one or more power factors by the manufacturer of the generator. The question of how to determine the regulation of the generator is usually decided by the actual conditions and facilities for testing. If it is possible to load the generator to full capacity it is an easy matter to obtain the per cent. regulation by using the following formula:—

$$\text{Percent Regulation} = \frac{(\text{No load volts} - \text{full load volts})}{\text{Full load volts}} \times 100$$

The voltage drop must be measured at the terminals of the generator at the rated speed, with the field current kept constant at such a value that full load current will flow in the external circuit. As it is usually not possible to obtain exact load conditions and load the generator at various power factors, it is more convenient to calculate the regulation from test data obtained at the factory. Tests should be taken on the generator to obtain values for the following:—

1. No load saturation.
2. Synchronous impedance.
3. Zero power factor load saturation.

The zero power factor saturation curve can be very closely obtained by over-exciting the generator while carrying a load of under-excited synchronous motors or generators. The power factor, though not exactly zero, is near enough for the obtaining of the zero power factor load curve from which the regulation for any load and power factor can be calculated.

The following description will help towards an understanding of the action of the generators and motors when run under these conditions:—The field of the generator under test is over-excited while the fields of the motors connected to the generators are decreased until full load current flows between the machines. By decreasing the excitation of the synchronous motors and increasing the excitation of the generator the voltage of the generator may be held at any desired value. The circulating current between the machines may be adjusted to any desired value by changing the field current of the generator. The sum of the field ampere turns of both machines determines the voltage, while the difference between the ampere turns of both machines determines the current that will flow. It is therefore evident from this that, if the fields of both machines are lowered together, the voltage will be lowered

while the circulating current will remain the same. Owing to the machines becoming unstable below a certain voltage it is desirable that care be taken to obtain satisfactory readings on low voltage without the machines falling out of step.

The zero voltage point on the zero power factor

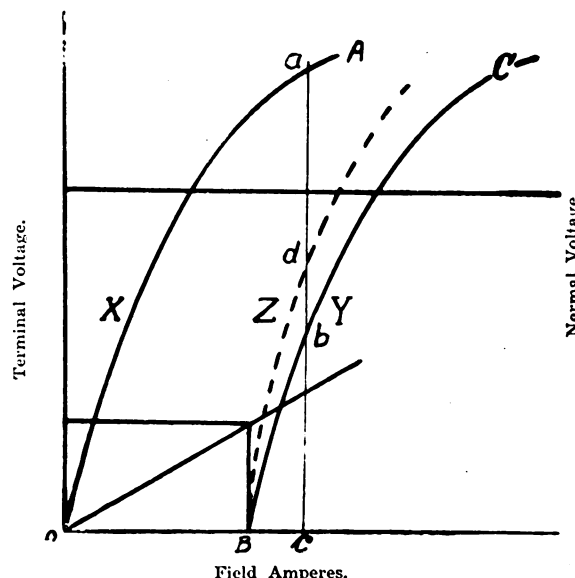


Fig. 1.

- X No load saturation.
 Y Zero power factor saturation.
 Z Full load saturation: P.F. Cos φ

curve may be taken from the short circuit saturation curve, as when the generator is operated on short circuit at zero voltage, the short-circuited circuit is of nearly zero power factor, so therefore the field current to produce full load armature current on short circuit is also the field current at which the zero power factor curve reaches zero (Fig. 1). It should also be noted that at any other power factor the zero voltage point will coincide with the zero power factor curve, as the calculated curves are for a given external power factor and not for the internal power factor of the machine tested.

There are several methods of calculating the regulation of alternating current generators, but we will consider only the following, which are in general use by most of the large manufacturing companies:—

1. Synchronous impedance method.
2. A.I.E.E. method.

The synchronous impedance method is generally the most easily applied, and the results obtained are on the safe side. It has been found that in nearly all machines checked both under

*Aust. General Electric Co., Melbourne.

actual load conditions and by the synchronous impedance method, that the regulation obtained by the latter method is usually slightly the higher. For obtaining the regulation by this method only the no load and short circuit curves

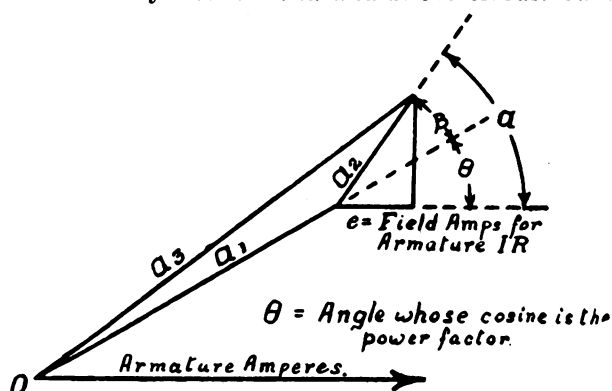


Fig. 2.

$$\cos a = \frac{a_2}{e} \quad \text{Field amps Syn. Impedance}$$

$$\cos \beta = \cos (a - \theta) = \cos a \cos \theta + \sin a \sin \theta$$

$$a_3^2 = a_1^2 + a_2^2 + 2 a_1 a_2 \cos \beta$$

of the generator are required. The various values of field current for the different load voltages may be calculated as follows:—

Let—

a_1 = field amperes on open circuit saturation (normal rated armature volts + IR drop at full load).

a_2 = field amperes required to make full load armature current flow.

a_3 = resultant field current calculated for any load multiplied by 115 per cent. (The reason for multiplying the resultant value of field current by 115 per cent. is that actual experience has shown that the field amperes thus obtained check very closely with the true value under load conditions.)

θ = the angle of which the power factor is the cosine.

a_3 = Field amperes at 100 per cent P.F.

$$= \sqrt{a_1^2 + a_2^2} \times 115 \text{ per cent.}$$

a_3 = Field amperes at 100 per cent load, any P.F.

$$= \sqrt{a_1^2 + a_2^2 + 2 a_1 a_2 \sin \theta} \times 115 \text{ per cent.}$$

The field current may also be obtained by means of vectors (Fig. 2) or directly from a chart as shown in Fig. 3. With the aid of the chart the calculation of regulation is a very simple matter, and much time and laborious work is saved.

From the calculated field current, the armature voltage corresponding to the field current at full load may be obtained directly from the plotted test results, as shown in Fig. 1, so that the regulation may be easily calculated from the formula—

$$\frac{(E_1 - E)}{E} = \text{per cent regulation}$$

Where—

E_1 = No load voltage.

E = Full load voltage.

The chart shown in Fig. 3 is approximately correct for power factors below 90 per cent., when the armature IR drop may be neglected; but when the power factor is above this value, the IR drop

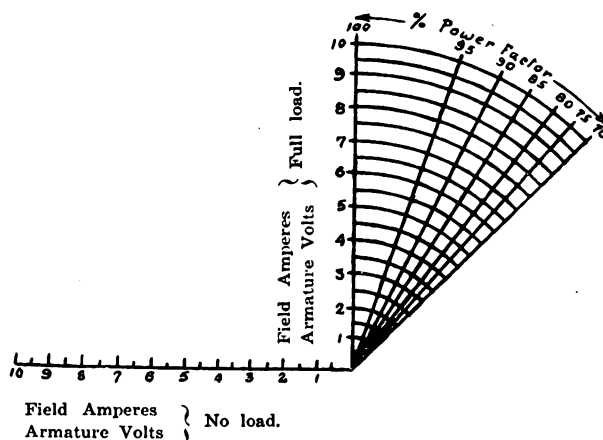


Fig. 3.

at full load must be taken into consideration by subtracting the IR drop at full load from the terminal volts at no load, thereby giving full load terminal volts at the calculated field current.

The A.I.E.E. method of obtaining regulation is as follows:—

It has been found from experience that the general shape of the zero power factor load curve

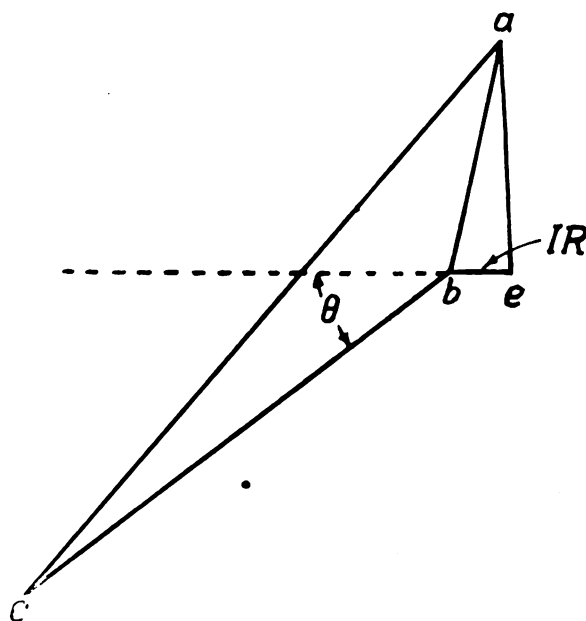


Fig. 4.

ac equals No load voltage.
bc equals Full load voltage.
ab equals Synchronous impedance.

within the range generally considered for obtaining regulation checks very closely with the no load saturation curve, so that, assuming a ficti-

tious armature reactance and reactive voltage drop, the no.load curve may be moved over horizontally and parallel to itself to any value of current corresponding to the load for which the regulation is required. Having obtained from test the open circuit, short circuit and zero power factor load saturation curves and plotted same as shown in Fig. 1, we can, by the use of vector diagrams, obtain the regulation for any load or power factor.

At a given field current, O_c (Fig. 1), the no load voltage is ca , and the zero power factor full load voltage cb , while the apparent internal volts drop is $ac - cb = ab$. The terminal voltage, dc , at rated full load current and at a power factor whose angle equals θ , can then be found by the use of

the chart shown in Fig. 3, or directly by a diagram as shown in Fig. 4. From Fig. 1 the following values are obtained and combined in their correct phase relations to form Fig. 4:—

ab = total internal volts drop.

ca = no load terminal volts.

Then cb (Fig. 4) is the full load terminal volts at power factor θ . This value is then laid off as shown in Fig. 1, indicated by cd . By finding a number of such points as d for various loads a curve may be drawn as shown by the dotted line in Fig. 1, the per cent. regulation being obtained from the formula—

$$\frac{(E_1 - E) 100}{E} = \text{per cent regulation}$$

Kiama, N.S.W., Municipal Electric Supply

In common with many other local authorities in New South Wales, the municipality of Kiama has inaugurated an electrical scheme, taking bulk

and for primary distribution through Kiama. The 6,600 volt energy is again stepped down at two outdoor sub-stations, one of which is illustrated

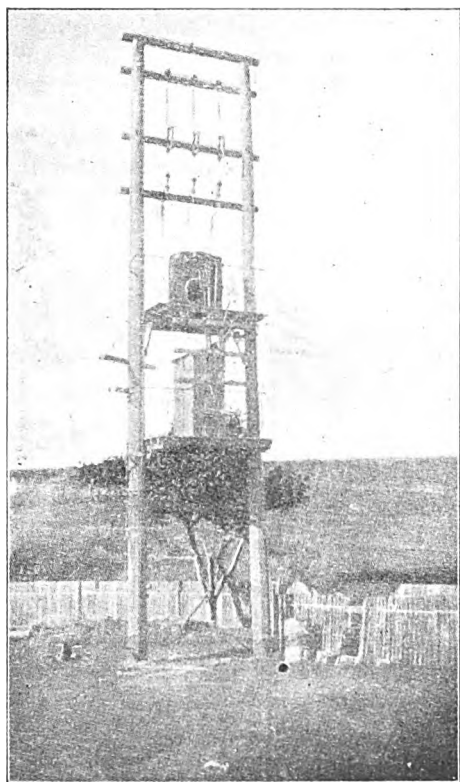


Fig. 1.

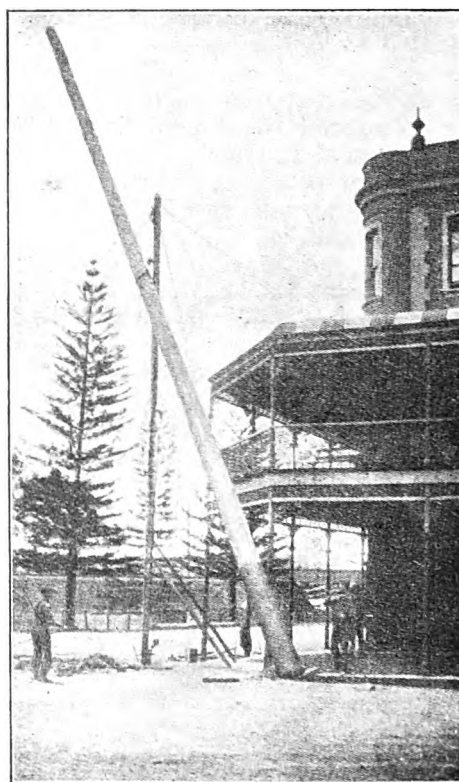


Fig. 2.

supply from a central station. Energy is purchased at 33,000 volts, three phase, 50 cycle, from the Government power station at Port Kembla, 21 miles distant. It is stepped down to 6,600 volts for supplying quarries in the vicinity of Bombo,

(Fig. 1), for secondary distribution at 415/240 volts three phase.

The poles carrying the primary distribution mains are of ironbark, 52, 60 and 65 feet in length. The wires are not carried at the pole tops, but

extra length has been allowed for carrying the 33,000 volt mains through the town in the event of the townships of Berry, Gerringong and Nowra deciding to take supply from Port Kembla. Poles of this length weigh between two and three tons each, consequently the work of erection has required no little skill. The reticulation work was carried out by Messrs. Ramsay, Sharp & Co. Ltd., and the method employed in erecting the poles is clearly illustrated in Fig. 2. The pole gang consisted of five men under a supervisor, and the work was done with the aid of a single derrick and crab winch.

The street lighting is wired on the series system, and is supplied from a constant current transformer, installed in the building which has been erected for the electric supply office and test room.

There are 16 250-c.p., 11 100-c.p., and 27 50-c.p. half-watt lamps, all of the bracket type. Current was switched on on January 31, and there are already 72 consumers. Lighting is charged for at 7d. per unit, and power at 4d. A simple method of billing has been established, the meters being read once a month and the account immediately handed to the consumer by the meter reader. If the consumer pays at once the meter reader issues the receipt, otherwise the account is payable within seven days at the council's office.

Mr. H. L. Watson is the resident engineer. The scheme was designed by, and installed under the supervision of Mr. H. J. Hoggan, consulting engineer, Sydney. The capital expenditure to date has been covered by a loan of £7,000 raised by the municipal council.

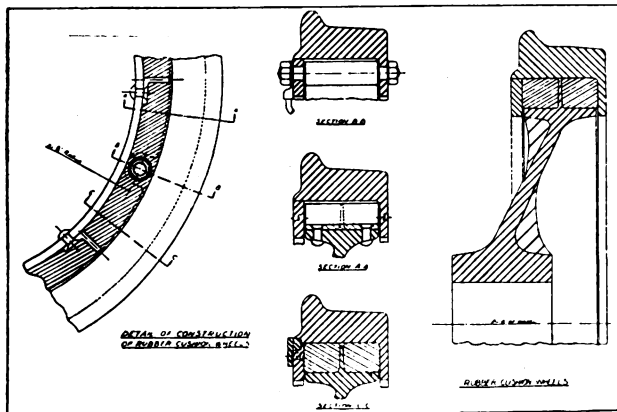
Reduction of Noise in Tramway Operation

The fact that noisy operation is indicative of wear, and is inevitably accompanied by high maintenance costs, is becoming increasingly appreciated in American tramway practice. A great deal of noise is preventable, without altering existing equipment, by keeping a close check on the condition of the permanent way, the car wheels, axle bearings, gearing, etc. Apart from this, however, suggestions are now being put forward for modifications in the de-

bond between the rim and the centre in order to carry the return current to the rails. Observations have indicated that the use of wheels of this type will effect a very material reduction in noise. The same company has found that the use of roller bearings for the axles, while effecting a great power saving, also tends to reduce noise. This, however, may only be apparent while the bearings are new.

A further suggestion, which it is thought might influence the noise problem, is that of suspending the motors from the car body and driving through a tail shaft and gearing in a similar manner to that adopted for trolley buses. This has already been tried out in Paris, but there is no evidence that cars so equipped are particularly quiet.

As far as investigations have been carried at present the cushion wheel appears to be the most likely modification of design to reduce noise. There is some little doubt whether the other expedients mentioned would have much effect after all. The main point, which all tramway operators will admit, is that the tracks and car equipment must be maintained in first class order. When this is done the noise problem will largely take care of itself.



Details of Rubber Cushion Wheel

sign of certain equipment, entirely with a view to reducing noise to a minimum. Practical use has been made of some of these suggestions, and a fair degree of success has been attained.

One operating company has experimented with a new type of wheel in which the rim is separated from the centre by a double row of resilient rubber blocks. Details of the design are illustrated in the diagram. With wheels thus constructed it is necessary to use a flexible

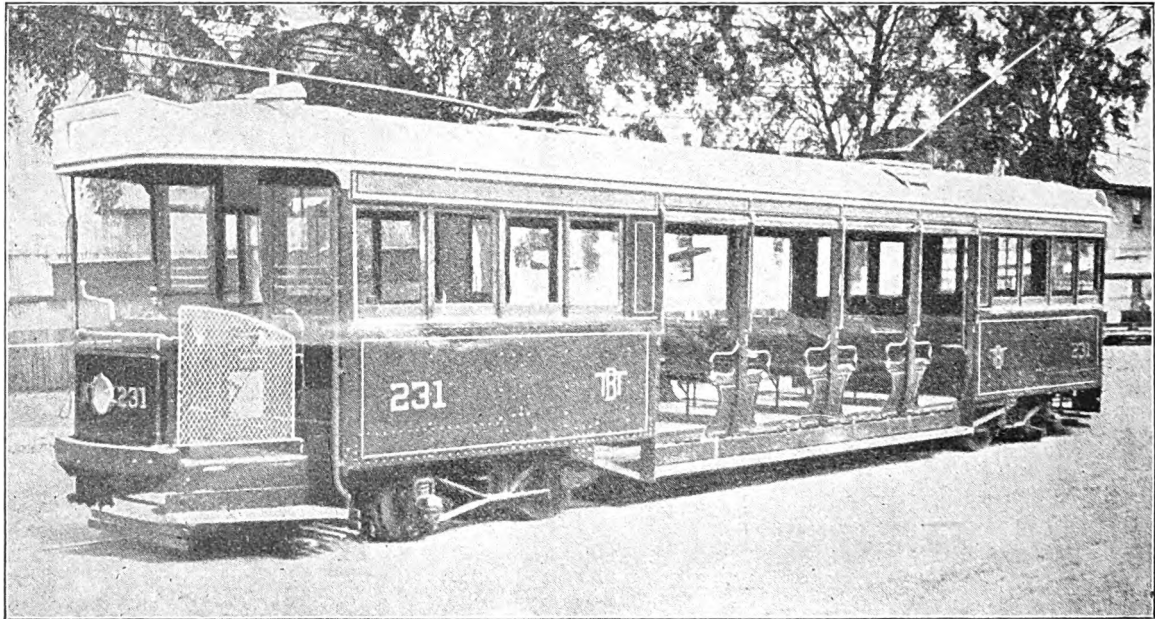
The electric supply committee of the Melbourne city council has recommended the acceptance of the following tenders for electrical plant:—10,000 yds. three inch fibre conduit, Western Electric Co. (Aust.) Ltd., £1,088/10/10; one 2,000 kw. rotary convertor, with spare parts and starting equipment, Metropolitan Vickers Electric Co. Ltd., £5,831/10/-; a.c. switchgear, Ferguson Pailin Ltd., £442/12/-; d.c. switchgear, Tombs and Howcroft Pty. Ltd., £2,290.

Brisbane Tramways

The Brisbane Tramway Trust, which was formed to take over the tramways from the Brisbane Tramway Co., has issued the report for the year ended December 31, 1924. During the period several extensions of tracks have been completed, increasing the route mileage from 42.59 (the figure at the time of taking over) to 47.12. In addition to opening new routes this work has involved the conversion of a length of single track

number of new cars up to 59, an increase of 32½ per cent. from the time the trust took over. Extensions are being made at the various depots to permit of more satisfactory maintenance work on the rolling stock, and plans are under way for a new large car barn and depot at Light Street.

The question of power supply has been causing the trust some concern, but no definite arrangements have yet been made. The present plants



Drop Centre Bogie Car for Brisbane Tramways. Seating Capacity, 64 Passengers

to double track. Several new extensions have been authorised and two of the routes are almost ready for service. In the matter of further extensions the trust is compelled to proceed slowly, as work can only be undertaken as funds are made available. The general policy is to use the tramways in assisting the development of new residential areas, but this of necessity means that new lines must be run for some time at a loss, due to the poor loading. In view of this, consideration is being given to running motor buses to act as feeders to the tramways, and to pioneer new tram routes.

In addition to new track extensions certain portions of the existing track are being relaid with heavier rails, and a great deal of expenditure has been incurred in putting the permanent way into good condition. To deal with the increasing traffic 18 new cars of the Dreadnought type and one 10-bench car were put into service during the year. Five more cars, including one of the drop centre bogie type, are now ready for service, and orders have been placed which will bring the total

are obsolete, and the trust has been considering the advisability of erecting an entirely new plant. In view of the fact that the City Electric Light Co. is about to erect a new station, consideration is being given to the purchase of all requirements from the company. The matter, however, is not yet settled.

The principal items of revenue and expenditure for the past two years, which are tabulated below, show the considerably increased costs which have proved to be necessary to the provision of safe and satisfactory service.

Operating results in pence per car mile for the last two years are as follow (year ended Dec. 31):—

	1923	1924
Traffic receipts	27.819	27.902
Expenditure—		
Transportation	11.282	11.327
Power	2.751	2.919
Car repairs	1.963	2.036
Maintenance of tracks and overhead equipment	2.570	5.308
General and administrative	1.870	2.024

Statistics for year ended Dec. 31:—

	1923	1924
Number of cars equipped	182	201
Miles run	5,212,971	5,457,800
Passengers carried	74,721,594	78,367,194
Traffic earnings	£604,251	£634,506
Sale of power and material	24,590	27,391
Advertising	—	1,850
Total receipts	628,841	663,747
Transportation	245,044	257,582
Power	59,760	66,376
Car repairs	42,641	46,304
Maintenance of lines and overhead structures (including relaying)	55,814	120,698
General and administrative	40,625	46,029
Interest	77,000	77,894
New cars	5,529	48,956
Duplicating tracks	12,267	26,821
New lines	4,500	47,249
Total working expenses	443,885	536,989
Net earnings	184,956	126,758

City Electric Light Co., Brisbane

The statement of accounts of the City Electric Light Co., Brisbane, for the year ended January 31, 1925, discloses a credit balance of £100,073, which with the balance brought forward from last year makes £100,179 available for distribution. An interim dividend paid in September last absorbed £51,565. Further dividends of 3 per cent. on the 6 per cent. preference shares, 3½ per cent. on the 7 per cent. preference shares, and 5 per cent. on the ordinary shares, have been recommended, and will require £48,597, leaving £17 to carry forward. The paid-up capital is shown in the balance sheet at £1,127,483; renewals, replacements and contingencies fund account, £179,623; franchise purchase sinking fund, £30,400; sundry creditors and deposits, £62,388; and bank overdraft, £17,934. Assets include freehold land, buildings, plant, etc., £1,235,938; cash at bankers on deposit, £110,000; purchase account, £62,723; sundry debtors, £44,899; and Commonwealth War Loan, £15,000. The profits earned during the previous year were £106,408, and dividends were at the same rate as for the year under review.

The company is erecting a new power station on the Brisbane River below Queensport. Orders have been placed for plant and equipment, and the work is now in hand. Negotiations with the Brisbane Tramway Trust regarding power supply have been in train for some time. The trust had proposed erecting its own power plant, but in view of the new construction being undertaken by the company, competent authorities have deemed it more advisable for the trust to take bulk supply. This matter, however, has not yet been finalised.

Sydney Electricity Supply Tariffs

The Sydney city council has given notice that a new scale of charges for electric supply will shortly be brought into operation. The new tariff, which was proposed by the city electrical engineer, Mr. H. R. Forbes Mackay, many months ago, will principally affect residential consumers, the general effect being to reduce charges and encourage the use of larger quantities of energy. The rates are as follow:—

Residence rates (applicable to premises used wholly or principally as private residences).—Whether the electricity is used for lighting, heating, or any other purpose, 5d. per unit up to 2½ units per quarter per 100 sq. ft. of area enclosed and covered by outer walls of buildings; 1½d. per unit for all beyond that quantity for single-storey buildings. The number of units charged at 5d. to be increased by 2½ per quarter per 100 sq. ft. for each floor above the ground floor.

Church rate (applicable to all premises used exclusively for public worship).—Whether the electricity is used for lighting, heating, production of power, or any other purpose, 3d. per unit.

Commercial rate.—Electricity used on premises other than residences, factories and churches, will be charged for on the maximum demand system at 5d. per unit for one hour's use of the maximum demand per day, and 1½d. for all units above that quantity. The same rate will be charged whether the electricity is used for lighting, heating, production of power, or any other purpose.

Factory rate (as at present, applicable when electricity is used in a process of manufacture or in the construction of buildings).—For production of power and for heating on a sliding scale from 1½d. to 6d. per unit, the price falling as the number of units used per quarter per horse-power connected increases. For light 4½d. per unit, or alternatively on the maximum demand system 5½d., for one hour's use per day, and 2½d. for all units above that quantity.

The rates for residences and churches will come into force from May 1, and the commercial rates from June 1. Applicants for supply in residences, whose applications are received before May 1, 1925, will have the option of being supplied at the new or the old rates. Applicants for commercial supply are notified that, although the tariff comes into force on June 1, it will not be possible to make the advantages of the rates available immediately owing to the necessity of alterations to the installations.

The Pacific Cable Board

The annual report and accounts of the Pacific Cable Board for the year ended March 31, 1924, outline the year's working and show that the receipts of £551,788 exceeded the ordinary working expenses (including the normal payment of £30,000 to the reserve and renewal fund) by £250,777. After taking account of the annuities of £77,544 payable to the National Debt Commissioners in respect of interest and repayment of capital, and of £9,150 payable to the reserve and renewal fund in respect of interest and repayment of money borrowed from that fund for the Sydney-Auckland Cable (1912), a surplus of £164,082 remained, and the Board is of opinion that the whole of it should be again devoted to the reserve and renewal fund. The traffic receipts, £544,781, exceeded those of the previous year by £35,482.

All the cables have been free from interruption throughout the year, and no repairs have been necessary. The new tricore shore-end at Bamfield on the Fanning Island section was laid in June, 1923, at a total cost of £21,246, and the modification of the shore-end has enabled improved methods of working to be adopted, with the result that the speed of working has been increased by nearly 20 per cent, i.e., from 110 to 130 letters per minute (paying traffic). But for this improvement, the system would now be seriously embarrassed, as the capacity of the cable would have been inadequate for the present volume of traffic. The new cables which were laid during the year under review between Auckland and Suva and between Sydney and Southport as part of the scheme for the duplication of the system, were brought into operation towards the end of 1923, and the anticipated improved circulation of traffic has been fully realised.

The actual cost of the new cables was £331,113, and has been provided from the reserve and renewal fund; £247,699 of this sum has entered into the accounts of the year under review, but the advantage of the increased carrying capacity cannot be fully utilised until the facilities north of Fiji are augmented. The Board considered providing additional means of communication between Canada and Fiji, the need for which is urgent, but a decision was deferred till the results of certain improved types of cables could be ascertained, and also in view of the discussions relating to wireless systems. The expedition which was sent to Vancouver Island and to Fiji to obtain data for high-power wireless stations in those localities had not completed the investigations at the close of the year.

Steam and Water Power

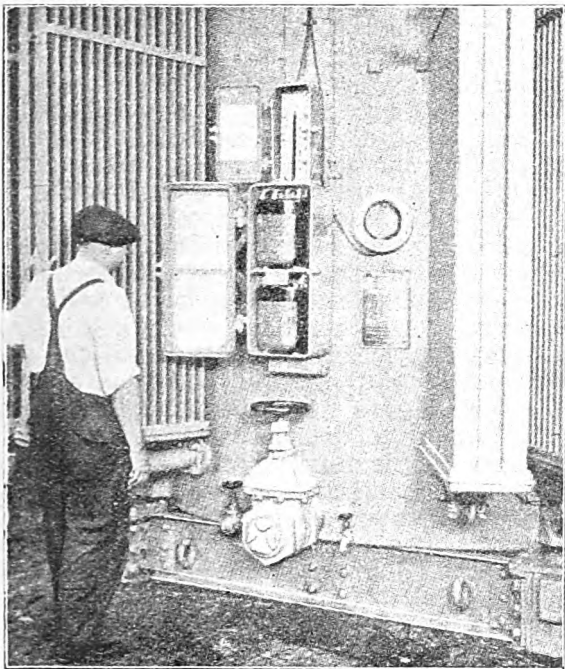
The necessity for an adequate provision of steam stand-by plant as an auxiliary to a hydroelectric system has recently been strikingly exemplified in California. In the interconnected systems of the California Edison Co., the Los Angeles Gas and Electric Corporation, and the Bureau of Power and Light of Los Angeles the state possesses one of the largest hydroelectric developments in existence. The sources of power and the area over which the interconnection operates are of such magnitude that it might have been supposed that the community would have an ample supply of energy under all conditions. This, however, has proved not to be the case for, owing to exceptionally dry weather during the season 1923-24, the water resources of the state became so depleted that it was faced by the prospect of a very serious power shortage. The situation was rendered more acute by the drought necessitating increased pumping for irrigation purposes, with consequent increased energy consumption.

A wholesale curtailment of energy output, which would have resulted in disastrous losses to many consumers, was only avoided by efficient organisation. A power supervisor was appointed, the co-operation of all energy suppliers was enlisted, every available steam and oil driven plant was pressed into service, and restrictions were imposed on the consumption of energy in every case where such would not involve direct financial loss to the consumer. With the help of this organisation, and the hearty co-operation of public bodies and many private consumers, the supply undertakings were enabled to carry on until general rains relieved the situation.

No blame is attachable to those who laid out the hydroelectric schemes for lack of foresight in providing water storage, for the rainfall and run off during the season were the lowest that had been experienced for 40 years. The situation, however, shows the inherent weakness of hydroelectric power even when all precautions are taken. In providing for future security the California Edison Co. is now diverting stream flow from another watershed into its principal storage reservoir at Huntington lake, but at the same time is taking no chances, and is bringing into operation a 70,000 kw. steam plant. The Los Angeles Gas and Electric Corporation also is putting down a steam plant, the first 30,000 kw. unit of which should be in service in July. With these provisions another shortage is extremely unlikely.

The Inertiaire Transformer

It is claimed that the Inertiaire transformer, developed by two of the engineers of the Westinghouse Electric and Manufacturing Co., has advantages which may ultimately cause it to supersede older types. The chief point in which it differs from other transformers lies in the provision of a device which ensures that the space above the oil inside the case is always kept free of oxygen, containing only the inert atmospheric gases, chiefly nitrogen. This is obtained from the outside atmosphere by a natural process. Oil expands and contracts



Inertiaire Transformer showing Deoxidising Device

according to temperature, and this expansion and contraction causes what is known as Breathing. Thus on expansion some gas is forced out and on contraction air is drawn into the container. The breathed air drawn into the transformer in this manner is made to pass in the Inertiaire transformer through a quantity of deoxygenating and dehydrating chemicals. In the passage through these chemicals the oxygen content and whatever moisture is present in the air are absorbed and dried nitrogen is drawn into the gas space.

Chief among the undesirable features of transformer oils is the tendency towards oxidation with the possibility of sludge formation when the oil is raised to moderately high temperatures in the presence of air. The nitrogen blanket prevents air from reaching the transformer oil,

and therefore eliminates the possibility of sludging. The second undesirable feature is the tendency to explosion above the oil surface resulting from arcing between the windings. The presence of an inert gas body prevents any explosion in this space. Still there is always a danger that some fault under the oil level may result in a primary explosion caused by the liberation of gases. These explosions are not so violent as those which formerly occurred above the oil level. For protection against this the transformer has a relief device in the top of the case. It consists of a circular diaphragm of thin sheet micarta clamped to a supporter placed directly beneath the manhole cover. The diaphragm is clamped in position with a ring and gasket forming under normal conditions a seal which is gas and oil tight. When an explosion occurs, the pressure ruptures the diaphragm and the manhole cover is forced open against the compression of springs on the holding bolts, far enough to permit the pressure to escape. Then the springs quickly bring the cover back to its original position in which it closes the opening. This operation does not permit the discharge of oil, or the diffusion of air into the transformer case.

Physically the Inertiaire transformer only differs from the old type in that a cabinet is mounted upon the side of the transformer case containing the deoxygenating and dehydrating chemicals and the breathing regulator which supplies the nitrogen, and in the relief device for abnormal pressure which is set in the cover of the transformer. The chief advantages are: prevention of sludge formation, exclusion of moisture, elimination of fire or explosion risk, and the provision of a useful cushion of compressible gas above the oil level. In a recent test of the type as many as twelve 40 gram. bombs were exploded in a transformer case at the one time, without damage to the equipment.

WOODEN POLES.

The general manager of the Auckland Power Board, N.Z., Mr. A. Wyllie, has recommended that the board continue its practice of using ironbark poles from which the sapwood has been sawn. He states that, although the dressing is somewhat costly, it results in sounder poles and a longer life, in addition to making a neat job. The cost of pole renewals has recently shown a tendency to increase in the country districts, but in spite of the higher price per pole Mr. Wyllie recommends the use of the best possible timber. He further recommends the continued use of square poles for lines of 11,000 volts and over, as the square hewing ensures nearly complete removal of the sapwood.

Complete Protection for Electric Irons

It has long been recognised that some device is necessary to prevent overheating of electric irons and similar devices through the current being inadvertently left flowing. Unfortunately the temperature limit of an iron under such circumstances is at such a figure that not only will the iron be seriously damaged; but it may be the cause of fire. Many proposals have been brought forward from time to time for dealing with this matter.

Indicating lamps, situated both at the plug switch and on the iron itself, have been used with a view to showing the operator when the current is on, but they have the disadvantage that the human element is still present. Fusible

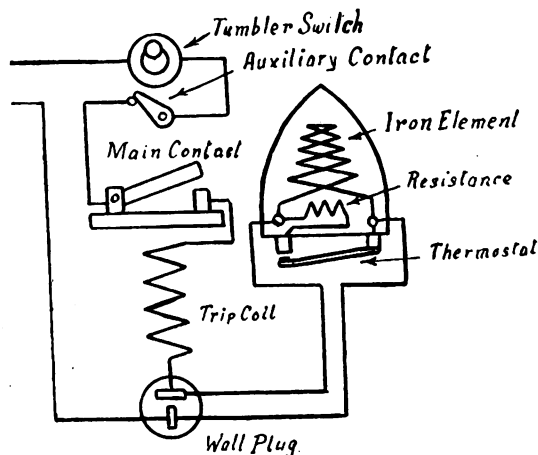


Diagram of Safety Device for Electric Iron

pins, similar to those used with electric kettles, only having a much higher melting point, are not suitable as they deteriorate under the constant high temperature of the iron. Experience has shown that for adequate protection any device used must be quite independent of the personal element, positive in action, easily reset by an inexperienced person, and absolutely foolproof.

A device incorporating all these desirable features has been invented in New Zealand and is now being placed on the market. It is known as the Stopfyre switch, and has received the unqualified approval of the fire underwriters and all interested bodies. It consists of two principal elements: a thermostat and contact carried on the iron, and an automatic overload cutout switch for mounting on the wall beside the plug. The thermostat consists of a bi-metallic strip carrying a contact on its outer end, which bends when the temperature rises above a pre-determined value, bringing the contact against a stationary contact and thus placing a resistance in parallel with the element of the iron. The thermostat, contacts and resistance are con-

tained in a small metal box attached to the heel of the iron. The resistance is so rated as to allow considerably more current to flow than if the iron element alone were in circuit. The cut out switch is operated by a small series solenoid, which under normal circumstances absorbs very little current. With the increased current flow, however, the solenoid is fully energised, the plunger flies up, and the switch is tripped. Thus on overheating the iron is automatically cut out of circuit.

The switch is of the free handle type, that is it cannot be held closed while the iron is still so hot that the thermostat contacts are touching. This feature renders it entirely foolproof. The hand operation is by means of a small knob which is turned to close the switch. The main contact is made by a small s.p. knife switch, but there is an auxiliary contact with carbon tips to take the arc on breaking. Both contacts have a quick break action so that there is no fear of the arc being held. The loose handle device consists of a spring arrangement, which brings the carbon contacts together before the main contacts, and a connection of the hand knob to the switch mechanism in such a manner that if the solenoid plunger flies up on contact being made, the switch will trip irrespective of whether the knob is held or not.

The device has been patented in all the principal countries of the world, and it is expected that it will have a very extensive field of application. As the diagram shows, no unusual wiring is required, thus the installation is simple. There is nothing likely to get out of order, and no difficulty in operation. Indeed, unless the switch trips through overheating of the iron there is no need to touch the equipment at all. The principle is simple, and the device may be applied to any apparatus requiring protection against overheating.

THE "ELECTRICIAN" ELECTRICAL TRADES DIRECTORY AND HANDBOOK.

Benn Brothers Ltd., London, p.p. 1,500. Published price, 25/- net.

The 1925 edition of this year book follows on the same lines as its predecessors. It is impossible in a short review to do more than mention a few of the features. The handbook section gives a mass of information about technical societies, patent law, telegraphs and wireless, the law relating to the supply and use of electricity, tramways, and other items.

A large part of the volume is taken up with alphabetically arranged and classified sections of the electrical engineering and allied trades of Great Britain. There are also similar sections for the British Dominions, Europe and U.S.A. The work bears evidence of careful compilation and will be found invaluable for reference.

THE EFFECT OF THE ELECTRIC RANGE LOAD ON DISTRIBUTION SYSTEMS

Many distribution engineers have expressed doubt as to the wisdom of encouraging the electric range load on systems that are already working to full capacity. The general opinion has been that the use of ranges would necessitate such an increase in transformer equipment and copper on distribution lines that the benefits of the increased central station load would be more than counterbalanced by the additional capital expenditure. Experience, however, has shown that, except under abnormal conditions, an existing distribution system will take care of a range load if this system is already serving a lighting load equal in rating. In other words, the distribution system which is already adequately serving a 20 kw. lighting load will serve satisfactorily an additional 20 kw. range load without increasing the size of copper. It may be necessary to move transformers to locations nearer to range customers, or to slightly increase transformer capacity in order to obtain better regulation, but copper additions should not be necessary.

The reason for this is the high diversity factor of the range load. Results of tests are available showing where 5 kw. transformers have been used each serving 50 to 60 kw. of connected lighting and range load. In American practice it has been found that there is such a time difference between the lighting and cooking peaks that the same plant is quite adequate to serve both loads. Of course this will not apply when the cooking load greatly exceeds the lighting, but when this point is reached there will be no room for doubting that increased copper and transformer capacity will be a good investment. Thus, when electric cooking in its initial stages can be catered for by the supplier with little if any additional capital expenditure, there is surely no reason why it should not be encouraged.

WOMEN'S ELECTRICAL ASSOCIATION.

The British Electrical Development Association forwards particulars of the Women's Electrical Association, an institution having as its object the promotion of the wider use of electricity in the service of women. The association has been formed through the activity of members of the Women's Engineering Society, working with the co-operation of women representing many professions. The importance of the work which the association is undertaking can scarcely be over-estimated. One of the principal factors holding up domestic electric development is the ignorance of the average housewife regarding the applications of electricity, and the conservatism arising from that ignorance. Many electrical dealers and supply authorities have been doing good work lately with demonstrations and advertising

matter, educating the public to the advantages and uses of electricity, but the new association is aiming right at the root of the matter. Once the women are convinced of the benefits arising from the use of electricity in the home, developments will be rapid, for it is the women that have the final say in domestic arrangements. The association is inaugurating a continuous educational campaign, using every known means of disseminating information, and it should not be long before the effects of its action are noticeable in increased activity in electrical development. Not only does the association aim at increasing domestic electrification, but at bringing knowledge of the advantages of electricity into every walk of life in which women are interested.

METROVICK AUSTRALIAN WORKS.

Metropolitan Vickers (Australia) Pty. Ltd. is being registered to take over the works of the Electric Equipment Manufacturers Pty. Ltd., of Melbourne, and to establish new works at Percy Street, Lidcombe, N.S.W. The formation of the Australian company is the outcome of the large contract obtained by the Metropolitan Vickers Electrical Co. Ltd. in connection with the Sydney railway electrification scheme. Under this contract a certain proportion of the work is to be done in Australia, and Metropolitan Vickers (Australia) Pty. Ltd. will be the manufacturing company. The work will include pantographs, resistance boxes, and junction boxes for 150 train equipments, and it is anticipated that this will keep the works employed for a period of twelve months. Deliveries under the contract will commence in October next. The manufacture of all classes of switchgear on which the Electric Equipment Manufacturers, Melbourne, have specialized will also be undertaken.

The company has acquired a block of five acres with railway siding. The first three bays of the works, covering about three-quarters of an acre, are in course of erection, and are being so laid out as to permit of extension as circumstances demand.

The directors of the company are Messrs. A. Maling (Metropolitan Vickers Electrical Co.), chairman; T. M. Ritchie (Sydney), managing director; H. J. Wright, and W. A. Dean.

The extension of the hydroelectric system in Tasmania, involving an expenditure of approximately £300,000, has been decided upon, and next week the government will call for tenders for the construction of diversion works, channel, and penstock chamber. Later, tenders will be called for the construction of a power station capable of satisfying a continuous demand of 12,000 horsepower. This will increase the capacity of the station to 82,000 horse power. The present surplus of power is about 10,000 horse power only.

Radio News

The Queensland government has been granted a B class license for a broadcasting station at Rockhampton. The wave length has been fixed at 323 metres.

The Broadcasting Co. of Australia Ltd. has made application for permission to reduce the wave length of its broadcasting station, 3LO, Melbourne. The present wave length is 1,720 metres and the power 5 kw. Tests have shown that a reduction to a wave length in the neighborhood of 400 metres will considerably improve the transmission for the amount of power used.

In connection with the forthcoming visit of the American fleet amateur experimenters will have the opportunity of carrying out some work on short waves. It is stated that Mr. F. H. Schnell, of the American Radio League will accompany the fleet for the purpose of experimenting on long distance communication. Provision has been made for transmission and reception on 20, 40 and 75 to 120 metres.

Experiments, which will be watched with great interest, will be carried out between Mr. Schnell, who is accompanying the visiting American fleet, and Lieutenant-Commander McDonald, who will be with the M'Millan expedition in the Arctic regions during the next few months. It is expected that it will be found possible to maintain two way communication between these experimenters on a wave length of 20 metres.

A "B" class broadcasting station, operated by Messrs. Wills and Co. Pty. Ltd., radio dealers, has commenced services in Launceston, Tas. The call number is 7BN, and programmes are to be broadcasted weekly. The apparatus used is a Meissner three coil circuit using two UV201A valves as oscillators, with Heising modulation using three UV202 valves. The preliminary transmissions have been very successful, and reports have been received from as far afield as the southern border of Queensland.

Amateurs in Ballarat, at a distance of about 60 miles in a direct line from Melbourne, report consistently satisfactory reception of the broadcasting station 3LO on crystal sets. The wave length of 3LO is 1,720 metres and its power 5 kw. The type of set most in favor, for which dealers find ready sale, uses a single circuit with honeycomb coil of 150 turns and a .0005 variable condenser in parallel. A fairly large aerial is of course necessary. Quite efficient results are obtained with a length of about 100 to 120 ft. of single or double wire, including the lead in, supported at about 30 ft. above surrounding objects.

Mr. M. Howden, of station 3 B Q, Box Hill, Victoria, has received word that a Morse message sent from his station on Jan. 24 was picked up by an experimenter in Finland. The distance covered, 15,000 miles, constitutes a record in long distance communication.

In a recent case at Camberwell, Vic., the postal department proceeded against an individual for assembling and selling radio receiving sets without a dealer's license. The evidence showed that the person in question had an experimenter's license and a transmitting and receiving license. The police magistrate held that the regulations under which the prosecution was launched were ultra vires, and dismissed the case with costs against the department.

A successful experiment was carried out recently by station 3LO, when speeches delivered at the A.N.A. smoke night in Ballarat were broadcasted from Melbourne. The speech currents were transmitted over one of the postal department's trunk telephone lines to the Broadcasting Co's studio in Melbourne, where they were amplified and sent on to the station at Braybrook for broadcasting in the usual manner. The experiment was quite successful, every word coming through quite clearly without any evidence of distortion. Ballarat is about 75 miles from Melbourne.

The short wave broadcasting station KDKA has recently been making attempts to obtain news of the missing Nutting arctic expedition, by sending out enquiries to the trading posts along Hudson Bay and the east coast of Baffinland. The Canadian Westinghouse Co. has recently supplied receiving sets to many of the lonely posts, and it is interesting to note the attempts being made to use them not only for recreation but for acquainting the inhabitants of the region with the fact that this expedition is evidently in difficulties somewhere within their vicinity.

The phenomenon mentioned in the last number of the "Electrical Engineer," in the note referring to the picking-up of a land line telephone conversation on a radio broadcast receiver, is evidently a variation of a well-known effect. When an aerial is erected adjacent and parallel to a telephone line it is often possible to pick up the telephone conversations through the capacity interaction of the telephone and aerial wires. In the Western Australian case referred to both aerial and telephone wires have been erected in country containing a large amount of metallic mineral. The ore body below the earth's surface would act in the manner of a neutral condenser plate, coupling the telephone lines to the aerial by capacity, and thus providing a direct path for the alternating telephone speech currents.

An attractive catalogue of radio sets and parts has been received from F. Vitus, Paris, France. The sets illustrated range from a crystal outfit to a five valve cabinet receiver, and show high class workmanship and attractive finish. Included in the accessories catalogued are several types of loud speaker, headphones, batteries, and rectifier. Useful hints for the erection and operation of receiving sets are given in a foreword, while an appendix gives lists of the principal broadcasting stations of Europe, with their wave lengths and hours of operation, and of amateur transmitting stations in France.

AUSTRALIAN BEAM STATIONS

Sites have been selected near Melbourne for the erection of the short wave beam radio stations for communication with Great Britain and Canada. The two transmitters will be erected about six miles south of Ballan, a town situated about 50 miles west of Melbourne on the main lines of communication between Melbourne and Ballarat. The receiving stations will be about 15 miles to the north west of Melbourne, near the towns of Keilor and Sydenham, close to the main road and railway between Melbourne and Bendigo. One transmitting and one receiving station will be devoted to direct communication with Great Britain while the others will communicate with stations in Canada.

The Marconi Co., which has the contract for the erection of these stations, will also erect feeder stations in each state, thus putting each capital city into communication with London. Two way working will be possible for the full 24 hours each day, and with the aid of automatic devices it is expected that high transmission speeds will be attained.

A SHORT WAVE PHENOMENON.

The remarkable effectiveness of short waves for long distance radio communication is well known, and lengths between 70 and 120 metres have now been in use by amateurs for international working for some time. Recent researches on shorter wave lengths have, however, disclosed new phenomena. In the region from about 80 metres upwards transmission is much more effective at night than in the daytime. But as the wave length is reduced the adverse effect of daylight becomes less marked, until in the neighbourhood of 30 metres equally good results are obtained with day and night working. Dropping now to 20 metres, it is found that, though transmission is particularly effective during daylight, the approach of darkness renders communication over any distance practically impossible. Whether still further reduction will bring to light more unexpected results remains to be seen. Amateurs in many places are now turning their attention to investigations of the ultra-short waves, and it should not be long before more data is available.

SILVERTONE BROADCAST RECEIVERS

The Ballarat Radio Listening-in Pty. Ltd., of Sturt street, Ballarat, Vic., manufactures several types of broadcast receiving set under the trade name of Silvertone. Standard one, two, three and four valve sets are built, also one and two valve amplifiers, and the larger sizes may be obtained in either English or American models. The tuned anode circuit is used, and the sets combine simplicity and stability of operation with purity of tone. The reception range is excellent and there is the additional great advantage of reasonable price. The single valve model, without accessories, is sold at £5/10/- and the four valve at £20.

Telephony and Telegraphy

Ten additional trunk telephone circuits are to be erected between Melbourne and Geelong in order to relieve congestion.

Two new automatic telephone exchanges for Melbourne suburbs are nearing completion, one at Ascot and one at Carlton. It is expected that the change over of the subscribers in these districts on to the new equipment will be effected during next month.

The postal department is inaugurating an extensive program of new automatic telephone exchange construction in metropolitan areas. In the Melbourne suburbs exchanges are to be built at Canterbury and South Melbourne. The former will have a capacity for 4,700 subscribers, with provision for ultimate extension to 8,000, while the latter will have a range from 3,300 to 5,800 subscribers. In New South Wales automatic exchanges will be opened at Randwick, Waverley, Gordon and Dee Why, with capacity for 4,300, 2,700, 1,400 and 350 subscribers respectively. In South Australia automatic exchanges are to be installed at Prospect, Glenelg, Brighton, Woodville, Henley Beach and Norwood.

COMMONWEALTH P.M.G.'s. DEPARTMENT Operations during March

New South Wales.—Two additional trunk circuits have been completed, the principal towns affected being Murwillumbah, Condong, Tumbul-gum, Cootamundra and Junee.

Sixteen country public lines were erected, providing facilities for 35 centres, and additional telegraph circuits have been completed between West Maitland and Werris Creek.

In the country 736 yd. of E.W. pipe was laid, and approximately 13 m. 1,700 yd. of cable ranging from 10 to 250 pairs was drawn in. Approxi-

mately 20 m. 1,372 yd. of cable was jointed, the conductor length drawn in and jointed being approximately 752 m. 170 yd. and 811 m. 160 yd. respectively. 1,408 yd. of aerial cable ranging from 13 to 25 pairs was also erected and jointed, the conductor mileage being approximately 19 m. 1,580 yd.

New exchanges have been opened at nine centres, approximately 160 services being provided for.

In the metropolitan area, 25 m. 400 yd. of cable ranging from 7 to 800 pairs was drawn in and jointed, the conductor length jointed being approximately 7,077 m. 1,300 yd.

Additional exchange equipment has been installed at Wallabadah, Cessnock, Robertson, Culcairn and Lockhart, and additional trunk equipment has been installed at Cessnock, Dungog and Lockhart. Additional exchange equipment has been provided at Ryde, Chatswood, Mosman, Vacluse and Balmain, approximately 600 extra services being provided for. Additional junction equipment has also been provided for at Epping, and the alteration of the loading positions at Drummoyne has provided for the connection of approximately 150 additional services. Delivery of the automatic equipment for City East (Sydney) exchange has been commenced and preliminary installation work is proceeding.

Victoria.—Three additional trunk circuits have been completed. The principal towns affected were Mernda, Doreen, Nutfield, Arthur's Creek, Yan Yean, Whittlesea, Eden Park, Coleraine, Melville Forest and Netherby.

Fourteen new country public telephone lines have been erected providing facilities at 16 new offices, and sixteen new exchanges have been opened.

In the metropolitan area $4\frac{1}{2}$ m. of E.W. pipes were laid and approximately $8\frac{1}{2}$ m. of cable ranging from 10 pair to 800 pair were drawn in, the conductor mileage being approximately 6,280 miles.

In the country, approximately $18\frac{1}{2}$ m. of cable ranging from 10 pair to 150 pair were drawn in, the conductor mileage being approximately 1,557 $\frac{1}{4}$ miles.

New switchboards have been fitted at four exchanges, and additional exchange equipment has been installed at 19 centres enabling approximately 970 extra services to be made available. Additional trunk equipment has also been provided at Wycheproof.

Queensland.—New offices have been opened and telephonic facilities provided at Bohvale, Dargal, Jaggan, Lanreef, Pine Creek and West Hill.

In the country 1,385 duct feet of conduit were laid, completing conduit works at Innisfail and Hughenden, and 1,800 yards of cable ranging from 10 to 100 pairs were drawn in. Additional exchange equipment has been installed

at 11 centres, and this will enable approximately 400 extra services to be made available. Additional trunk equipment has also been provided at four offices.

In the metropolitan area 1,456 duct feet of conduit and 1,936 yd. of Hume pipe were laid. In the Brisbane City area 1,520 yd. of cable ranging from 1 to 75 pairs, and in the suburban area 630 cable pair miles of cable ranging from 4 to 200 pairs, were drawn in. Also 1 mile of 50 pair trunk cable was drawn in and jointed in South Brisbane to provide lead in for all South Coast trunks.

In connection with the installation of the South Brisbane automatic exchange, the whole of the manual substation equipment, excepting public telephones, has been replaced by automatic apparatus. The tapping-in of 8,000 cable pairs to this exchange has also been completed.

South Australia.—Four additional trunk circuits have been completed, the principal towns affected being Gladstone, Laura, Crystal Brook, Narridy, Clare, Farrell's Flat, Saddleworth and Auburn.

Two new country public lines were completed, providing telephone facilities between Chandada and Poochera, and Blanchetown and Swan Reach.

In the country $3\frac{3}{4}$ m. of single duct conduit were laid and $2\frac{1}{4}$ m. of cables ranging from 25 to 100 pairs were drawn in and jointed—the total conductor length jointed being 106 miles. Additional exchange equipment was installed at six offices, and this will enable approximately 140 extra services to be made available. Additional trunk equipment has also been provided at Balaklava.

Contracts have been let for the installation of automatic exchanges at Unley, Norwood, Prospect, Glenelg, Woodville, Henley Beach and Brighton. The initial capacity of these exchanges will provide automatic equipment for 13,100 subscribers.

Western Australia.—Four additional trunk circuits have been completed; the principal towns affected being Perth, Nundijong, Williams, Bunbury, Busselton, Moora and Wetheroo.

Twelve country public telephone lines were erected, providing facilities for 21 centres.

An additional telegraph circuit has been completed between Bunbury and Busselton.

New exchanges have been opened at Charlies Creek, Mt. Stirling, and Wuraga, approximately 60 services being provided for, and additional exchange equipment has been installed at seven centres, approximately 253 extra services being provided for.

Tasmania.—Five additional trunk circuits have been completed; the principal towns affected being Hobart, Bothwell, Otlands, Cygnet, Woodbridge, Scottsdale and Tulendeena.

One country public line has been completed, providing telephone and telegraph facilities at Egg Lagoon, King Island.

In the metropolitan area approximately 1,170 yd. of concrete pipe was laid.

In the country approximately 3 m. 587 yd. of concrete pipe was laid.

Additional exchange equipment has been installed at Hobart, approximately 160 extra services being provided for, and a new exchange has been opened at Weldborough.

Trade Notes

Large Cable Order.—The Adelaide Electric Supply Co. Ltd., Adelaide, Sth. Australia, recently placed with W. G. Watson and Co. Ltd., Sydney, an order for the supply and delivery of 80 miles of 7/.0935 steel-cored aluminium cable, the product of the British Aluminium Co. Ltd., London.

William Adams and Co. Ltd. of Sydney, recently received an order from the New South Wales public works department for the supply of 108 miles of 7/.146 hard drawn aluminium cable for use in connection with the Burrinjuck hydroelectric scheme. The wire will be manufactured by Metal Manufactures Ltd.

Lascelles Parrington Ltd., 101-3 King street, Melbourne, announce that they have opened an electrical accessories department, embracing a most comprehensive stock of general supplies. This department will be under the management of Mr. W. H. Woodward who has had an extensive experience and has been connected with the electrical trade for a number of years.

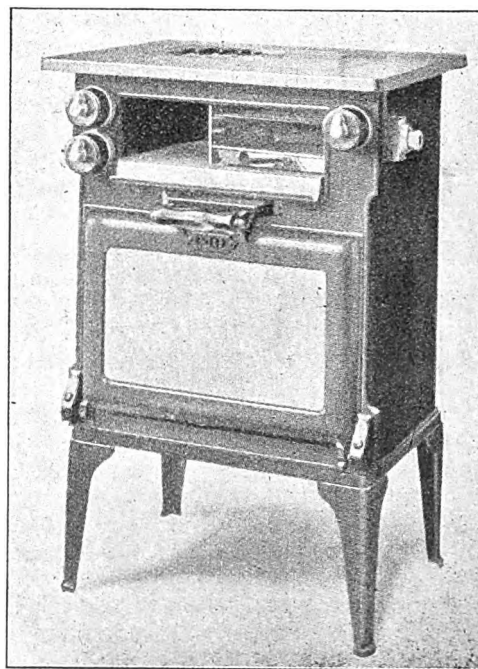
The Australian General Electric Co. Ltd., which has hitherto been represented in South Australia by agents, has opened a branch office and show rooms at 27-29 Grenfell street, Adelaide, under the management of Mr. S. B. Cox. Mr. J. A. Smith will have charge of the engineering department, and Mr. C. Crome will be in charge of the merchandising department.

Brush-Ljungstrom Turbo Set.—An order has been placed by the N.S.W. Public Works Department with the Brush Electrical Engineering Co. Ltd., Loughborough, England, for supply and delivery of one 1500-kw. Brush-Ljungstrom turbo-alternator set for the Port Kembla power station, to supplement the two similar units which have been in use for some years. A feature of the order is the short time of delivery promised by the Brush Co. The order was placed on December 31, 1924, and the set is to be erected and running on October 1 of this year. It is expected that the machine will be shipped from England this month. The Brush Electrical Engineering Co. Ltd. is now directly represented in Australia by Major Coulston, whose office is at Commerce House, Flinders Street, Melbourne.

E.M.F. Transformers.—The E.M.F. Electric Co., of Kavanagh street, South Melbourne, Vic., announces that it is now in a position to quote for any size of transformer. The larger sizes will be to the designs of a leading overseas manufacture. Recent orders carried out include 130 to the New South Wales railway and tramway department and 75 for the Victorian railways.

Electrical Price List.—The Melbourne house of W. G. Watson and Co. Ltd. has issued a very complete illustrated price list of electrical accessories, compiled along similar lines to the lists which have been for some time a feature of the firm's Sydney trading. In addition to the usual fittings, appliances, lamps, etc., the list covers a large range of electrical home needs. The prices are subject to alteration without notice, but new issues of the list will be made from month to month in order to keep up to date.

Falco Electric Cooker.—Falco electric heating and cooking apparatus is manufactured in Great Britain under arrangement with the Hotpoint company of America. The stoves, of which there are several models, combine certain typi-



Falco Stove

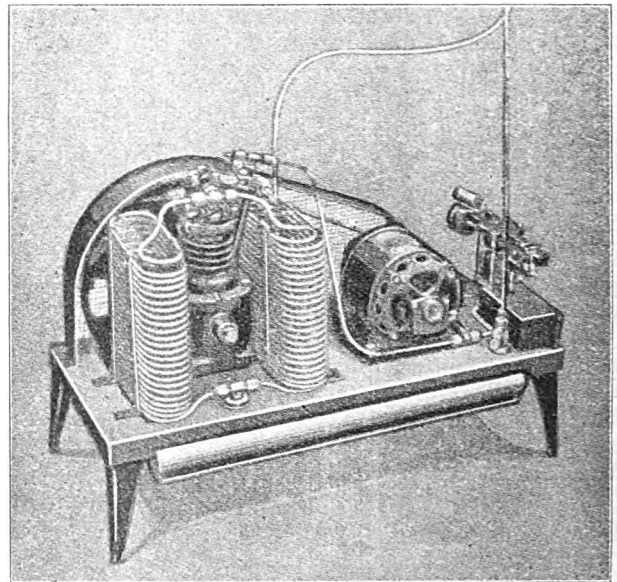
cal points of British and American design. The general construction is sturdy and well able to stand up to average usage. The sides and back of the stove are built up of sheet metal on a strong framework, but the front, which is most liable to jarring owing to slamming of the door,

is constructed of cast iron. The oven, which is equipped with side elements, is well lagged. In the model illustrated the oven elements are rated at a total of 1,500 watts and are controlled by a three heat switch. A boiling plate and griller also each rated at 1,500 watts are provided, and the stove is retailed at £27/12/6. All operating switches are of very strong construction, and there is little fear of damage to switches, wiring or any of the electrical equipment. The hot plates for Falco stoves are made up either in the open or enclosed type, as experience has not yet demonstrated which is the best when both efficiency and reliability are taken into account. Falco products, which also include irons, radiators, grillers and other small cooking devices are handled in Victoria by Messrs. Warburton Franki (Melb.) Ltd.

Bruce Peebles Dynamo Electric Machinery.—Messrs. Noyes Bros. (Melb.) Pty. Ltd. and Noyes Bros. (Sydney) Ltd., with branches in all states, have been appointed sole representatives in Australia of Bruce Peebles and Co. Ltd., Edinburgh, an old established firm manufacturing dynamo electric machinery. The products of the firm are already well known in Australia, and carry a high reputation for quality and reliability. In substation equipment the firm has specialised in motor convertors, and statistics show that during a period of six months last year orders for this type of plant showed an increase of over 75 per cent above those received during the corresponding period of the preceding year. In mining work the experience has been particularly wide, and many large collieries in Great Britain are almost exclusively equipped with Peebles machinery both above and below ground and in fiery and safe positions. Power factor improvement is now receiving serious attention and Peebles synchronous motors are being used in this connection in many situations. A large Australian cement works has placed orders for two 1,200 h.p. motors of this type. Peebles motors and generators are included in the equipment of many of the manufacturing concerns in Newcastle and in some of the Queensland sugar mills. Reference to Tait's Electrical Directory will disclose that many Peebles generators have been in service for years in electric supply undertakings in all states of Australia.

The Frigidaire Domestic Refrigerator.—Delco-Light products are almost universally known, and their reliability and efficiency have been proved in long service. The self-contained electric lighting plants and water pumping systems are probably the best known of these products, but the Delco-Light Co., for whom Messrs. Warburton, Franki Ltd. are agents in Sydney and Melbourne, has recently been giving attention to other appa-

ratus, including a washing machine, a portable power device and an electrically-driven refrigerator for domestic use. The Frigidaire refrigerator consists in its essentials of an electric motor-driven two-cylinder compressor and a cooling element which may be located at anything up to 50ft. from the compressor. The cooling element is placed in a heat insulated cabinet. The operation of the system is extremely simple. The refrigerant, sulphur dioxide, is compressed in the compressor unit and allowed to expand in the cooling element. In expanding it absorbs heat from the element and the interior of the cabinet. It is then drawn back to the compressor, the same gas being used for an indefinite period. The machine is entirely automatic and maintains a



The Frigidaire Compressor Unit

temperature well under 50 degrees Fahr. in the warmest part of the cabinet. The air in an ice chest depending for its cooling on the melting of ice is necessarily damp, but the Frigidaire cabinet is always dry. In fact, salt or matches may be kept in the cabinet without deterioration. Although ice is not necessary with this system, provision is made in the cooling element for freezing trays of ice blocks for use in drinks, salads, etc., or icecream and frozen desserts may be made in the trays. The Frigidaire is made in sizes suitable for use in cabinets from 9 to 35 cub. ft. capacity. A useful application of this system is the Frigidaire ice cream cabinet, which entirely displaces the present method of keeping ice cream by means of cracked ice and salt. In shops where ice cream is retailed, this machine fills a long-felt want.

RADIATOR SEASON.

With the approach of winter the electrical supply houses are laying in stocks of radiators, and local manufacturers are busy meeting the demands of the trade. The radiator is, next to the electric iron, the most saleable electrical household appliance, and if every electrical contractor made a point of canvassing each client many addi-



New "Magnet" Fire

tional sales would result. There must still be many householders using electric light who have not experienced the comfort of an electric fire always ready to throw out its heat rays. In these days, when it is necessary to reduce household drudgery to a minimum, the electric radiator almost sells itself if brought directly under the notice of the prospective user.

A visit to various trade houses shows that there has been no radical departure in types, although several new and artistic models are exhibited by well-known manufacturers. Hecla fires are well to the fore, in many attractive designs, while the Thermoleo products of the Leonard Electric Co. also demand attention. Amongst imported articles the Magnet fires, manufactured by the British General Electric Co., show neat design and rugged construction. The illustration depicts one of the latest models which will shortly be available. This heater is 12½ in. in height, 13½ in. wide and 7½ in. deep. The element is controlled by a two-heat switch, providing for either 1000 watts or 1500 watts consumption.

The Irish Free State has accepted a report by Messrs. Siemens-Schuckertwerke, of Berlin, for the construction of a large hydro-electric power scheme on the Shannon River, which will supply energy to the majority of the towns of over 500 inhabitants. Three 30,000 h.p. units will be installed in the first instance. The Government has not yet decided whether it will operate the scheme, or hand the control over to the promoters—consulting engineers—contractors.

QUANTITY PRODUCTION OF ELECTRICAL APPLIANCES

The Electrical World, in a recent editorial, pointed out that the main factor which stood in the way of the wholesale adoption of electrical domestic appliances was high first cost. It suggested that the time was ripe for organisation of electrical manufacturing along the lines employed by Henry Ford in the automobile field, in order to bring prices within reach of the majority. In a later issue of the same journal J. H. Reichart, the president of a company manufacturing electric cookers, writes to say that his firm is putting the Ford principles into practice, and achieving marked success. The firm manufactures a small cooker which, 18 months ago, was wholesaled at £2/4/-. Starting on the Ford method the price was cut in two, the quality still being maintained at the same level. This brought the price considerably below cost, but improvements in manufacturing methods and processes soon resulted in profits once again. Still, however, the volume of sales did not increase as it should. Prices were again reduced to a figure below cost, and further refinement of production made, until profits appeared once again. This time the sales responded and the company now makes a thousand cookers where formerly it made a hundred. In general the quality of the article has been improved, so that the present cooker is better than the original, though its price is now only 14/6.

The chief difficulty encountered has been in making the retailing companies understand that they will gain by taking small profits on each sale, relying on volume for their earnings. But even though the manufacturer is handicapped by his distributors the Ford method is proving a great success. Mr. Reichart considers that if his company had been manufacturing vacuum cleaners or washing machines the growth of business would have been even more remarkable, for these lines are more firmly established than electric cookers. He considers also that it is only a matter of time before other manufacturers start in on the same principles, making the cost fit the price, and depending on volume of sales for profits. When this comes about the electrical industry will start to move in real earnest.

POSITIONS VACANT

The Albury municipal council, N.S.W., invites applications for the position of electrical engineer at a salary of £500 per annum. Applications close on May 6.

The Hydro-Electric Department, Tas., has invited applications, closing May 6, for the position of chief engineer and general manager to the department.

Electrical Supply Undertakings of Australia

SOUTH AUSTRALIA

Town or City	Supply Authority	Type of Plant	Capacity	Distribution System	No. of Consumers
Adelaide	Adelaide Electric Supply Co. Ltd.	Steam	37,250 kw.	400/200 volts, 50 cycle single phase a.c.	53,702
"	Municipal tramways trust	"	10,500 kw.	Tramway supply only	—
Angaston	Adelaide Electric Supply Co. Ltd.	—	—	400/230 volts, 50 cycle three phase a.c.	—
*Balaklava	"	Suction gas	50 kw.	460/230 volts, d.c.	—
Bordertown	Border Electric Supply Co. sells in bulk to municipal council	Crude oil	20 kv.a.	415/240 volts, 50 cycle three phase a.c.	30
Burra	Burra Electric Supply Co.	"	54 kw.	—	—
Clare	Mid-North Electricity Co.	"	190 kv.a.	—	—
Crystal Brook	H. C. Gadd sells in bulk to municipal council	"	48 kv.a.	415/240 volts, 50 cycle three phase a.c.	170
Daveyston	Adelaide Electric Supply Co. Ltd.	—	—	400/230 volts, 50 cycle three phase a.c.	—
Freeling	"	—	—	"	—
Gawler	"	—	—	"	—
Greenock	"	—	—	"	—
Hamley Bridge	J. G. Traegar	—	—	200 volts d.c.	—
Jamestown	Municipal council	—	—	460/230 volts d.c.	—
Kadina	Municipal council	Crude oil and suction gas	190 kw.	220 volts d.c.	600
Laura	"	Bulk supply	—	—	—
Loxton	Murray Engineering Co.	Crude oil	80 h.p.	440/220 volts d.c.	50
Maitland	S. McPharlin	"	27 kw.	230 volts d.c.	—
Mannum	A. Vivian sells in bulk to municipal council	"	18 kw.	220 volts d.c.	50
Millicent	Municipal council	Suction gas	47 kw.	240 volts d.c.	—
Minlaton	S.Y.P. motor works	"	12 kw.	230 volts d.c.	71
Moonta	Municipal council	"	45 kw.	"	310
Mt. Barker	Adelaide Electric Supply Co. Ltd.	Steam and suction gas	50 kv.a.	400/230 volts, 50 cycle three phase a.c.	—
Mt. Gambier	Municipal council	Suction gas	135 kw.	460/230 volts d.c.	310
Mt. Lofty	Adelaide Electric Supply Co. Ltd.	—	—	400/230 volts, 50 cycle three phase a.c.	—
Murray Bridge	Murray Bridge Electric Supply Co. Ltd.	Suction gas and crude oil	182 kw.	"	406
Naracoorte	Naracoorte Electric Power Co.	Crude oil	60 kw.	440/220 volts d.c.	150
Nuriootpa	Adelaide Electric Supply Co. Ltd.	—	—	400/230 volts, 50 cycle three phase a.c.	—
Orroroo	District council	Suction gas and crude oil	40 kw.	240 volts d.c.	—
Peterborough	Municipal council	Suction gas	115 kw.	460/230 volts d.c.	—
Port Augusta	"	Bulk supply	—	440/220 volts d.c.	200
Port Pirie	"	"	—	440/230 volts, 50 cycle three phase a.c.	—
Quorn	"	Crude oil	57 kw.	230 volts d.c.	250
Renmark	"	Suction gas	135 kw.	460/230 volts d.c.	340
Strathalbyn	"	"	60 kw.	220 volts d.c.	200
Tanunda	E. Schrapel and Sons Ltd. sell in bulk to municipal council	Crude oil	20 kw.	"	95
Victor Harbor	Harbor Electrical Co. Ltd.	—	68 kv.a.	415/240 volts, 50 cycle three phase a.c.	210
Wallaroo	Municipal council	Bulk supply	—	220 volts d.c.	400
Yorketown	S. W. Grabia	Crude oil	11 kw.	"	100

*To be changed over and supplied from Adelaide in near future.

Lighting and Power

Auckland, N.Z.—The Waitematu power board has decided to take a poll of ratepayers on the question of raising a loan of £200,000 for electric supply reticulation.

Ballarat, Vic.—The Electric Supply Co. of Victoria is commencing work on changing over the supply to the outer districts of the city from d.c. to three phase a.c. The city council and the electricity commission have granted permission for the running of a high tension pole line for supplying Ballarat East. Dressed poles are to be used and the work will be put in hand immediately.

Bellingen, N.S.W.—The shire council has adopted the report on an electric supply scheme submitted by Mr. R. J. N. Franki, consulting engineer, Sydney.

Bendigo, Vic.—The Electric Supply Co. of Victoria is commencing work on changing over to the outer portions of the city from d.c. to three phase a.c.

Blacktown, N.S.W.—The shire council has approved of the electrical extensions proposed by Mr. R. J. N. Franki, consulting engineer, Sydney.

Brunswick, Vic.—The electric supply undertaking of the city, which has been operating on bulk supply from the Melbourne city council, has changed over on to a bulk supply from the electricity commission.

Clare, S.A.—The Mid-North Electricity Co. Ltd. announces a special issue of 14,000 £1 shares to enable it to cope with the increasing demand for electric supply. It is stated that the cost of the undertaking as originally planned will be lower than the estimates, and there are indications that a sufficient number of consumers are awaiting supply to place the company upon a profit earning basis from the commencement of operations. The erection of the power house, the reticulation and house wiring are proceeding, and it is expected that supply will be available on July 1.

The company has placed contracts for equipment in addition to the generating plant as follows:—Six panel switchboard and high tension switchgear, Electric Equipment Mfrs., Melbourne; copper cable, Elder Smith and Co., Adelaide; high tension insulators, Parsons and Robertson, Adelaide; low tension insulators, Aust. Porcelain Co., Melbourne; meters, Electricity Meter Manufacturing Co. Ltd., Sydney; three 50 kv.a. three phase, 50 cycle 11,000/415/240 volt transformers, Metropolitan Vickers Electrical Co. Ltd.; ironbark poles, 35, 40 and 50 ft., Gibbs Bright and Co., Adelaide; stringy-bark poles, 30 ft., O. W. Probert, Forest Range, S.A.; erection of poles and stringing wire, Clements and Stewart, Lilydale, Vic.

Condoblin, N.S.W.—Mr. R. J. N. Franki, consulting engineer, Sydney, advises that the following tenders have been accepted in connection with the electricity undertaking:—Engines, Ruston and Hornsby; alternators, Australian General Electric Co.; switchboard, British General Electric Co.; meters, Electricity Meter Manufacturing Co.; insulators, Canney and Towe; copper cable, Wm. Adams & Co.; poles, R. J. White; installation work, Commonwealth Electric Co.. The supply will be 415/240 volts, three phase, 50 cycle a.c.

Corowa, N.S.W.—The Victorian electricity commission is supplying, at a cost of £150, a new engine crankshaft to replace the one recently broken at the power house. It is stated that the commission will be able to make bulk supply available for the town by the end of the year and that the whole of the work involved in the change-over should be completed by March, 1926.

Devonport, Tas.—The agreement in connection with the taking over by the hydroelectric department of the municipal council's plant has been finalised. The department has agreed to delete its claim for £247 for reconditioning the plant.

Dimboola, Vic.—The shire council is calling tenders for the supply, delivery and erection of a crude oil engine, and for the supply of two d.c. generators for the power station.

Gerrigong, N.S.W.—The council has approved of an amended scheme for an electric supply undertaking estimated to cost £9,500. A referendum of ratepayers is to be taken regarding the borrowing or the money. The proposed charges are: Lighting, 10d.; domestic power, 5d.; industrial power, 3½d.

Gisborne, N.Z.—The Poverty Bay power board has informed the borough council that, when power is available, it will be able to give supply at £15 per kv.a. of maximum demand per annum, on the condition that the borough guarantees a minimum consumption of 700 kv.a. for two years, and an increase at the rate of 10 per cent per annum up to five years. As the demand increases the rates will be reduced.

Gundagai, N.S.W.—The shire council has adopted the report of Mr. W. Corin, consulting engineer, Sydney, on an electrical undertaking for the district, and is borrowing £5,500 to carry out the proposal. The supply system is to be 415/240 volts, 50 cycle, three phase a.c.

Hay, N.S.W.—Mr. G. E. Richards, electrical engineer, of Sydney, has offered to supply electric current for public purposes, provided the municipal authorities grant a franchise for twenty-five years. The proposed maximum charges are: lighting 1/4; power, 8d. Subject to the endorsement of the council's solicitor the aldermen have expressed approval of the scheme.

Katoomba, N.S.W.—The official switching over of the electric supply from private enterprise to municipal control took place on March 31. To date the meter connections total 919.

Killarney, Q'ld.—The Glengallan shire council has appointed Mr. A. E. Harding Frew, Brisbane, its consulting engineer to report on a water supply and lighting scheme for the town of Killarney.

Lilydale, Vic.—The electricity commission has taken over the supply undertakings of Lilydale and Croydon from the shire council. The distribution is at present single phase, but it will be changed over to three phase during the next twelve months.

Lismore, N.S.W.—The municipal council proposes borrowing £20,000 for the purpose of reorganising the electricity supply throughout the district. Mr. Guy Allbut, of Newcastle, has been retained in a consulting capacity.

Macleay, N.S.W.—The municipality intends borrowing £4,000 for electric supply purposes.

Mittagong, N.S.W.—The Nattai shire council intends borrowing £3,400 for the purpose of installing electricity in Burradoo.

Mildura, Vic.—A loan is being raised for municipal works which includes a sum of £500 for installation of plant at the power house.

Mornington, Vic.—The electricity commission has approved of the shire council borrowing a further amount of £400 for work on the extension of electric supply to Mount Martha.

Mt. Barker, S.A.—The plant and undertaking of the Mt. Barker Electric Supply Co. has been sold to the Adelaide Electric Supply Co.

Napier, N.Z.—The borough council is entering into an agreement to take a bulk supply of 400 kv.a. from the Hawke's Bay power board. Power will be delivered at 3,300 volts and the charge is not to exceed £6 per kv.a. per annum, plus a service charge of £200 per annum, plus ½d. per unit. The council is to have full authority to use its own generating plant in any manner that may be considered advisable.

Nyah, Vic.—Mr. A. E. Treasure electrical engineer, Swan Hill, Vic., is furnishing a report on a proposal to supply electricity in the district.

Orange, N.S.W.—Tenders are being invited for the supply of a 750 kw. turbo-alternator for the municipal power station. Mr. A. M. Conway is the electrical engineer and Mr. W. Corin, of Sydney, the consultant.

Palmerston North, N.Z.—A conference has been held between the borough council and the Manawatu-Oroua power board in an endeavour to arrive at a satisfactory basis for the supply of power by the latter to the former. The matter of the comparative costs of operation of the borough council's power plant and of the power board's scheme is being investigated.

Penguin, Tas.—The electric supply was officially switched on on Mar. 24. Energy is purchased in bulk from the government hydroelectric department and distributed at 400/230 volts, 50 cycle three phase a.c.

Penrith, N.S.W.—The council has decided to borrow £7,000 for electric supply extensions.

Prospect and Sherwood, N.S.W.—The municipality intends borrowing £6,000 to cover extension of electric supply to Pendle Hill and Girraween.

For the current year a profit of £2,173 was made on the electric light undertaking and as a result it has been decided to reduce the charges to the following: Lighting, 7d. to 6d.; power, 4d. to 3d. per unit. A proposal to borrow £11,500 for electricity extensions and duplications is also under consideration.

Ringwood, Vic.—The electricity commission has taken over the electric supply undertaking formerly operated by the Lilydale shire council. Three phase current is supplied from the commission's subsidiary transmission line.

Rochester, Vic.—The Commonwealth Electric Co. has offered the whole of its supply undertaking and pumping plant to the shire council for £13,000.

Shannon, N.Z.—An agreement has been arrived at between the council and the Korowhenu power board under which the latter will supply street lighting for £3/17/6 per lamp per annum.

Stawell, Vic.—The approval of the electricity commission has been given for the installation of an 190 h.p. gas producer to supplement the present plant.

Te Aroha, N.Z.—The original scheme for electric supply, undertaken by the Thames Valley power board, is now practically complete. The work has been carried out at a saving of approximately £43,000 on the estimates, the total cost being £514,000. This is largely accounted for by the

fall in costs of labor and material, which has amounted to about seven per cent since the works were commenced. The agreement with the engineers, Messrs. Gauvain and McLeod, has been terminated, the board expressing satisfaction with the work of the firm. Mr. Gauvain is to be appointed consulting engineer to the board.

Wagga, N.S.W.—The municipal council, acting upon the recommendation of Mr. C. H. Chaston, municipal engineer, has undertaken to link up with the public works department's Burrinjuck hydroelectric scheme, provided the following conditions are fulfilled: That Wagga be included in the ring system; and that the charge does not exceed one penny per unit; that a reduction will be made when the consumption exceeds 2,500,000 kw. hr., providing the present load factor of 52 per cent is maintained.

Wellington, N.Z.—The power supply from the Mangahao hydroelectric station was switched on on Mar. 26. At present the city is only taking a bulk supply of 5,000 kw., using its own generating plant for the remainder of the load, but it is proposed to increase the bulk supply up to 11,000 kw.

West Maitland, N.S.W.—At a recent meeting of delegates from the surrounding municipalities and shires a resolution was carried requesting the public works department to prepare reports on a hydroelectric scheme at Barrington Tops.

Westport, N.Z.—An order in council has been gazetted, authorising the borough to use water from Christmas creek, Lake creek and Lake Rochport for hydroelectric purposes, and to erect electric supply lines in the district.

Whittlesea, Vic.—The progress association is making enquiries from the electricity commission regarding the possibility of an electric supply service for the district.

Winton, N.Z.—The borough council is transferring its electric supply reticulation, excluding the street lighting, to the Southland power board for £1,050.

Yarrowonga, Vic.—There is a difference of opinion as to the best steps for ensuring the reliability of the electric supply for the near future. The shire council desires to borrow about £3,000 and instal new plant, which course is favoured by the consulting engineers, Messrs. Christie and Gardiner. A majority of the ratepayers, however, considers that the existing plant can be overhauled, and with the addition of a small engine borrowed from the electricity commission, will be able to supply the wants of the town for some time to come.

Mr. J. Batchelor has been appointed electrical engineer to the shire in succession to Mr. Walsh, who has gone to Koriot.

Current Prices for Electrical Supplies

The quotations in this list represent the average retail selling prices ruling in Melbourne during the month of publication. These prices are subject to bona fide traders' discounts. Special rates are obtainable in most cases for large quantities. In general Sydney prices are slightly lower.

Adaptors—

Hardwood	doz.	11/3
Parallel	each	6/6

Blocks—

3 in. round	gross	22/6
3½ in. round	gross	25/-
6 in. x 3 in. rectangular	doz.	6/8
9 in. x 3 in. rectangular	doz.	8/9
6 in. x 6 in. square	doz.	12/6

Bushes—

½ in. ideal metal	gross	7/6
¾ in. ideal metal	gross	7/6

Bushes—

½ in. ideal metal	gross	8/9
¾ in. plain wooden	doz.	1/6
¾ in. plain wooden	doz.	1/8
1 in. plain wooden	doz.	2/-

Bells and Bell Material—

Bell transformers	each	12/6
1½ volt dry cells	each	3/4
Bell wire—1/029 d.c.c.	1,000 yd.	32/6
1/036 d.c.c.	1,000 yd.	42/6
1/029 d.c.c. and i.r.	1,000 yd.	50/-
1/036 d.c.c. and i.r.	1,000 yd.	60/-

Bells and Bell Material—

No. 2 porous pots	each	2/1
No. 2 jars	doz.	8/9
No. 2 zincs	each	1/3
Salammoniac	lb.	1/3
2½ in. wood box bells	each	4/6
2½ in. iron box bells	each	4/6
3 in. wood (church gong)	each	18/4
Bell presses	from each	3/9

Pocket Lamp Batteries—

Batteries, pocket lamp	each	1/10
2-cell batteries	each	2/5
3-cell batteries	each	2/8

Ceiling Roses—

		English	Japan
2-plate	doz.	11/8	6/3
3-plate	doz.	15/	8/9

Connectors—

1-way, porcelain	doz.	2/6
2-way, porcelain	doz.	4/
3-way, porcelain	doz.	5/

Counterweights—

Porcelain	each	2/6
Brass	each	5/6
Shot for same	lb.	6½d.

Casing and Cover—

Best white pine	100 ft.	12/6
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Conduit—

		Plain	Screwed
½ in.	100 ft.	10/	22/6
¾ in.	100 ft.	10/10	22/6
1 in.	100 ft.	16/3	30/
1 in.	100 ft.	27/6	42/6
1½ in.	100 ft.	45/	70/
1½ in.	100 ft.	68/	100/
2 in.	100 ft.	—	150/
¾ in. oval	100 ft.	12/6	—

Conduit Fittings—

		½ in.	¾ in.	1 in.
Grip—Tees	doz.	6/	6/3	8/
„ Elbows	doz.	4/9	5/	7/
„ Couplings	doz.	3/6	3/9	5/
Crampets	gross	5/5	5/5	6/3
Saddles	gross	5/	5/	5/5
		½ in. & ¾ in.	¾ in.	1 in.
Screwed tees	doz.	5/5	7/6	
„ elbows	doz.	3/9	5/5	
„ couplings	doz.	2/9	4/	
„ bell mouths	doz.	5/5	5/5	
„ „ „ 1 in.	doz.		14/10	
„ „ „ 1½ in.	doz.		19/6	
„ „ „ 1½ in.	doz.		27/	

Junction Boxes—

		½ in. & ¾ in.	¾ in.
2-way	doz.	10/10	10/10
3-way	doz.	11/3	11/3
4-way	doz.	11/8	11/3

Fuses (Cut-outs)—

		British	Japan
5 amp, anchor type	doz.	11/3	6/3
5 amp, round chamber	doz.	17/6	8/9
8 amp, round chamber	doz.	25/	12/6
10 amp, oblong	doz.	45/	25/
20 amp, oblong	each	—	3/

Holders—

		English	Japan
C/G., S./C. holders	doz.	13/4	9/2
½ in. and ¾ in. holders	doz.	13/4	9/2
Batten holders	doz.	15/	11/3

Lamps—

Metal Filament, Vacuum Type			
25 to 250 volts, 20 to 60 watt	each	2/	
20 to 250 volts, 100 watt	each	3/6	

Gas-filled Type

20 to 250 volts, 25 to 40 watt	each	3/	
All voltages	60 watt	each	3/6
	75 watt	each	4/
	100 watt	each	5/6
	150 watt	each	7/3
	200 watt	each	9/
	300 watt	each	13/
	500 watt	each	17/6
	750 watt	each	22/6
	1000 watt	each	27/6
	1500 watt	each	40/

Carbon Filament

All voltages, 5 to 32 candle power	doz.	24/
All voltages, 50 candle power	doz.	42/

Plugs—

5 amp two pin plugs	doz.	32/6
5 amp two pin tops	doz.	15/

Switches—

		English
5 amp s.p. pol. brass	doz.	18/9
5 „ s.p. ox. copper	doz.	21/6
5 „ 2-way pol. brass	doz.	32/6
5 „ 2-way ox. copper	doz.	38/6
10 amp. s.p. pol. brass	doz.	40/
5 „ d.p. pol. brass	doz.	42/6
10 „ d.p. pol. brass	doz.	90/
5 „ s.p. ceiling switches	each	5/6
5 „ 2-way ceiling switches	each	7/6
1 „ ceiling switch and rosette	each	5/
3 „ American tumbler	doz.	25/
3 „ s.p. indicating rotary	doz.	27/6
3 „ s.p. non-indicating rotary	doz.	23/6
3 „ 2-way rotary	doz.	56/3
5 „ d.p. indicating rotary	doz.	62/6
10 „ d.p. indicating rotary	doz.	78/
20 „ d.p. indicating rotary	doz.	150/

Switchboards—

		English	Japan
Single circuit marble 5 amp	each	11/3	9/2
Single circuit marble 10 amp	each	18/9	16/3
Two circuit marble 5 amp	each	20/	16/3
Two circuit marble 10 amp	each	25/	22/

Switchboard Frames—

6 in. x 6 in. local make	doz.	9/6
6 in. x 8 in. local make	each	1/
8 in. x 8 in. local make	each	1/3
8 in. x 10 in. local make	each	1/6
10 in. x 10 in. local make	each	1/8

Tape—

Black adhesive	lb.	2/9
Pure rubber	lb.	10/

Wire and Cables—

	Per 1,000 yd.
1/.044, 600 meg.	£5 12 6
1/.064, 600 meg.	£8 12 6
3/.036, 600 meg.	£9 15 0
7/.036, 600 meg.	£17 0 0
7/.044, 600 meg.	£21 10 0
7/.064, 600 meg.	£36 10 0

Flexibles—

	Per 100 yd.
23/36 cotton	£2 2 6
40/36 cotton	£2 12 6
70/36 cotton	£3 10 0
110/36 cotton	£4 5 0

Electrical Contracts

Full information regarding contracts invited and accepted is published every week in "Tenders," a registered newspaper issued from the office of "The Electrical Engineer." Subscription, 20/- per annum.

COMMONWEALTH

P.M.G.'s Dept., General.—75 combined voltmeter and milliameters, Lawrence and Hanson Electrical Company.

Dept. of Works and Railways.—Installation of 3 electric elevators, G.P.O., Sydney, Standard-Waygood Ltd.

STATES

State Electricity Commission of Vic.—22,000 V. cable, British Insulated & Helsby Cables and Western Elect. Co., S and C fuses, Lawrence & Hanson Elect. Co. Ltd.; transformers, Noyes Bros. (Melb.) Pty. Ltd.

Victorian Public Works Dept.—Installation of electric lighting and power and alterations to present systems, technical school, Footscray, Minster Bros.

Victorian Railways.—Cable, dry core, British Insulated and Helsby Cables Ltd.; Electric runabout crane, J. L. Newbigin Pty. Ltd.; welding apparatus, Robert Bryce and Co. Pty. Ltd.; petrol electric lorry cranes, Horrocks Roxburgh Pty. Ltd.; stranded copper cable, British Insulated and Helsby Cables Ltd.

Victorian State Coal Mine.—Induction motors and starters, State Mine station, Siemens Bros. and Co. Ltd.

West, Aust. Govt. Tender Board.—3 "Ferranti" transformers, J. R. W. Gardam; 1 transformer complete with oil, Electrical Plant Manufacturers Ltd.

West. Australian Government.—Power plant for Perth power house, 12,500 kw., turbo-alternator, condensing plant, circulating pumps, etc., C. H. Parsons & Co. Ltd.; boilers, economisers, mechanical stokers, etc., Babcock and Wilcox Ltd.; switchgear, 500 k.w. turbine, station transformers, Metropolitan Vickers Electrical Co. Ltd.

GENERAL

Adelaide Electric Supply Co. Ltd.—80 miles aluminium cable, W. G. Watson & Co. Ltd.

Condobolin Municipality, N.S.W.—Electric supply plant, generators, Australian General Electric Co. Ltd.; engines, Ruston and Hornsby (Aust.) Ltd.; switchboard, British General Electric Co. Ltd.; meters, Electricity Meter Mfg. Co. Ltd.; insulators, Canney and Towe; cable, Wm. Adams & Co. Ltd.; installation, Commonwealth Electric Co. Ltd.

Metropolitan Board of Water Supply and Sewerage, Sydney.—Large size electric cable, Siemens Bros. & Co. Ltd.; Noyes Bros. (Syd.) Ltd., W. T. Henley's Telegraph Works Co. Ltd.; 50 amp. generator, O'Donnell, Griffin & Co. Ltd.

Melbourne and Met. Tramway Board.—Automatic sub-station equipment, English Electric Co.; Australian General Electric Co.

Melbourne City Council.—Half-watt suspension lanterns, Foy & Gibson Pty. Ltd.; reflectors, Australian General Electric Co. Ltd.; fibre conduit, Western Electric Co. (Aust.) Ltd.; 2,000 k.w. rotary converter, Metropolitan Vickers Electrical Co. Ltd.; a.c. switchgear, Ferguson, Pailin Ltd.; d.c. switchgear, Tombs and Howcroft Pty. Ltd.

Mid-North Electricity Co. Ltd., S. Aust.—Two 100 h.p. engines, 75 kv.a. generators, 50 h.p. engine, and 40 kv.a. generator, Fairbanks Morse Co. (Australasia) Ltd.; switchboard and H.T. switchgear, Electric Equipment Mfgs. Pty. Ltd.; cable, Elder Smith & Co. Ltd.; H. T. insulators, Parsons and Robertson Ltd.; L. T. insulators, Australian Porcelain Co. Pty. Ltd.; meters, Electricity Meter Mfg. Co.; transformers, Metropolitan Vickers Electrical Co. Ltd.

Sydney City Council.—Three d.c. Coane type motors, Crompton & Co. Ltd.

NEW ZEALAND

Dunedin City Council.—Triple-braided cable, Carter, Desmoulins Ltd.

Napier City Council.—(a) Poles and cross-arms, Richardson McCabe and Co.; (b) Cable, Turnbull and Jones, V.I.R.

and T.B.; (c) Insulators and shackles, National Electric Co.

New Zealand Public Works.—Oil-test sets, National Electric Co.; floodlight projectors, British General Electric Co.

Otago Electric Power Board.—Transformers, Paterson and Co., A. D. Riley and Co, National Electric Co., Turnbull and Jones; meters, Carrick, Wedderspoon Ltd.

Taumarunui Borough Council, N.Z.—400-6,000 volt insulators, A. D. Riley and Co. Ltd.

TENDERS OPEN COMMONWEALTH

Dept. of Works and Railways.—April 27—Electric light and power installation, Sydney, G.P.O.

P.M.G.'s Dept., General.—May 19—Telegraph paper tape, iron work. May 26—Metal jointing sleeves. June 2—Telephonists telephones. June 16—Transformers. Aug. 11—Plugs and sleeves.

P.M.G.'s Dept., Victoria.—June 16—Transformers.

P.M.G.'s Dept., N.S.W.—May 17—Accumulator plates and separators. June 4—Accumulator and counter e.m.f. cell batteries, Randwick, Waverley, Gordon and Canberra exchanges. June 11—Motor generator sets.

STATES

N.S.W. Railways and Tramways.—April 22—Electrical cables and wires; 3,000 k.v.a. transformer for Zarra street power house. May 6—Impedance bonds, 10 miles 250,000 c.m. weatherproof cables. July 8—Supply and erection of two coal elevators for White Bay power house.

State Electricity Commission of Victoria.—April 27—Switchgear and accessories. May 11—Varnished cambric cable. May 18—Busbar supporting insulators, 6,600 and 22,000 volt; V.I.R. control gear. June 15—Bare hard drawn copper cable.

Victorian State Rivers and Water Supply Commission.—April 21—2 k.w. electric generating set.

Victorian Public Works.—April 23—Switchboard, Footscray Technical School, installation electric lighting, Mont Park Hospital.

Victorian Railways.—April 29—Rotary convertor and accessories, copper cable and accessories. May 6—Self-contained portable petrol engine driven electric welding plant, battery booster charging sets, starting apparatus and accessories, desk type fans. May 27—High speed turbine lathe and electrical equipment. June 3—2,200 volt cable; electrically operated tuning fork; telephone cables. July 1—Electric cables (spares).

GENERAL

Brisbane Tramway Trust.—May 27—Tramway sub-station equipment.

Melbourne City Council.—June 15—High and low tension three phase sub-station switchgear.

Northcote City Council, Vic.—April 27—Poles, bare copper cable.

Queensland Public Works Dept.—May 1—Electric lift, Treasury Buildings.

Rockhampton City Council, Q'ld.—April 29—Transformer oil dryer. 33,000 volt oil and insulation testing set.

Sydney City Council.—May 4—5,000 volt potential transformers. May 4—Double braided weatherproof cables, a.c. consumers electricity meters.

Sydney Harbor Trust.—May 4—Two 2-ton electric hoists runways, 5-ton electric overhead bridge crane.

NEW ZEALAND

Auckland Electric Power Board.—May 25—Rotary converters; transformer; rotary balancer; electric crane.

Public Works Dept.—April 28—50,000 volt transformers, Section 117 Waikato. June 23—Portable oscillograph.





Editorial





SYDNEY POWER SUPPLY

The dispute between the New South Wales government and the Sydney city council in regard to the additional generating equipment which will be required approximately five years hence still continues. The city council having cancelled the contract for a bulk supply from the government after 1930 is proceeding as rapidly as possible with the preliminary arrangements for the erection of a new power house on a site to be acquired at Botany. Specifications for the plant are being drawn up with a view to giving the greatest possible encouragement to Australian tenderers. Turbines of about 20,000 kw. capacity, running either at 1,500 or 3,000 r.p.m., are to be installed.

The government's case is that the city council's own expert brought from abroad advised it to continue the bulk supply, as the cost was lower than the figure at which the council was generating. The council refused to accept this advice claiming that whilst their present costs with a more or less obsolete plant were higher, there was no good reason to assume that with a modern plant they could not generate just as cheaply as the government, and they would therefore save the government's profit on the bulk supply. Further, the council claims the right to control its own affairs for the benefit of the citizens. The council also stresses the point that it has the largest supply business in the metropolitan area, and is therefore justified in desiring to have its own generating station. One point which has a bearing on the subject is the economic limit of power house capacity. Apparently the demand in Sydney will warrant at least two power houses of 100,000 kw. capacity, and that being so, it is doubtful whether there would be any material advantage in having the whole generating equipment under the one control. It would be quite as advantageous if two stations of this size were laid down with a view to inter-connection, even though they were not under the same authority. So far as the plant already installed by the government is concerned, it is claimed that this will all be required for railway electrification and other purposes quite apart from the city council's demand.

As pointed out in these columns previously, it is not a matter of moment whether the government or the council generates the energy required. The main points are, that the supply is available and that the price is right. Public money is involved either way, and the final

argument should be based on the thought of service to the people of the city and state. There should be no need for the government to try and coerce the city council, or to threaten it. The government has handled the negotiations clumsily. Even its latest action in appointing a committee of local engineers to report is unlikely to further a settlement. The one course of action which might have brought the parties together would have been the appointment of an impartial engineer, preferably from one of the other states. Such a man could be secured, and if he had the confidence of both the government and the council, his decision would be conclusive. It is not too late even yet to adopt this course.

BEAUTY OR UTILITY

If the Niagara Falls were fully developed for the generation of electrical energy one of the scenic wonders of the world would be practically destroyed. Power users both in Canada and the United States have been agitating for years to develop more energy from the waters, but the respective governments have successfully withstood the materialistic designs of those who would destroy the beauty of the falls for the sake of dollars.

A similar agitation is now proceeding in New Zealand. Bowen Falls, at the head of the famous Milford Sound, in the fiordland of Otago, is considered one of the finest scenic spots in the southern hemisphere. Recently a syndicate approached the government for a license to utilise the falls for power purposes, primarily in connection with the extraction of nitrates from the atmosphere. The proposal has raised a veritable howl of protest from all parts of New Zealand. The tourist department naturally is averse to anything being done which would detract in the slightest degree from what is one of its chief attractions; and it has to be remembered that New Zealand is to some extent dependent on the tourist traffic which is bound to grow as the years go by if the resorts are carefully preserved. The promoter, Mr. A. Leigh Hunt of Wellington, stresses the commercial aspect, and points out the considerable saving to farmers which would result from the establishment of the industry. On the other hand it has been asserted that, in anticipation of the license being granted, speculators have been at work, so that the power scheme threatens to become of secondary importance.

If the promoters could back up their claims with any evidence that the Milford Sound is

the most suitable location for such works there might be something to be said in favor of their applications; but in view of the wonderful hydro-electric resources of the Dominion there does not appear to be any necessity to do anything which would detract from the natural beauty of the Bowen Falls. In the Southern provinces of New Zealand there are numerous places where nitrogen fixation works might be located with equal advantage to the promoters.

THE INDUSTRIAL HEATING LOAD

The character of central station loading has undergone a considerable change since the inception of the electric supply industry. In the early days the lighting load dominated the field. At a later stage the increasing use of electrical energy for motive purposes caused the power demand to take first place. In recent years a new competitor has appeared, which, in the opinion of many, may outstrip even the motor load. The use of electrically generated heat, in both domestic and industrial service, is steadily coming into favor, winning its way by reason of the unique advantages of electricity over every other source of heat. The applications cover a very wide range, both in the temperatures required and in the nature of the processes. Such, however, is the adaptability of electrical energy, that by its agency heat may be applied in ways that would be impossible of attainment with any medium depending upon direct combustion. At the same time the efficiency at the point of consumption is remarkably high.

Electric heating falls quite naturally into two divisions: applications at high temperatures, and those requiring only medium or low temperatures. Amongst the former are the various types of electric furnace for preparation and treatment of metals, and the processes of arc and resistance welding. The loading of some of these processes, particularly where furnaces of the direct arc type are used, has been until recently of a nature not always acceptable to the central station engineer, owing to liability to sudden fluctuations which put a heavy strain upon equipment. But more modern refinements, notably the introduction of the induction furnace, are producing a much more desirable class of load. It is not so much, however, to the high temperature applications that the supply undertakings must look for their future development, and particularly for that improvement of load factor that is so desirable, but to the processes utilising moderate temperatures. Electric baking of bread and pastry on a commercial scale has already been mentioned in these columns as worthy of development, to the advantage of supplier and consumer of energy alike. This, however, is but one application pointing the way to investigation and experiment in other fields.

Some of the larger electrical manufacturing concerns, notably in the United States, have been carefully looking into the question of developing electrical heat treatment processes, and are being heartily supported in their work by the central stations. The result of this co-operation is that the economics of certain processes, such as the enamelling of metal parts in automobile manufacture, have been entirely revolutionised, with an accompanying substantial betterment in the quality of the finished products. At the same time the suppliers of energy have benefitted by the development of a load which, in the case of a.c. systems is of almost unity power factor, and which, in many instances, has a remarkably good load factor. Where intermittent heat is required arrangements can usually be made for the heating to be done at off peak periods. This helps the supplier by improving his twenty-four hour load factor, and at the same time makes power available to the consumer at very reasonable rates. A considerable levelling up of daily load curves may be expected at stations supplying industrial loads as soon as the advantages of electricity as a source of heat are appreciated. An article on another page deals further with the advantages of electric heating, and describes two Australian installations which are proving the economy of the method.

CONTROL OF MELBOURNE TRAMWAYS

The Victorian government has under review the question of reconstituting the authority controlling the Melbourne tramways. At present the system is under the administration of a board of seven members appointed for a term of three years. The term of the present board expires in November next, and the question of future control must be faced almost immediately. Three definite suggestions are likely to come up for consideration: (1) That the board be reconstituted in a manner that will give more direct representation to the metropolitan municipalities; (2) That the control of tramways be vested in a board of three experts to be appointed by the government; (3) That the control be placed in the hands of the railway commissioners.

The scheme most favored in political circles at present is that of appointing a board of three experts, presumably with powers equivalent to those of the railway commissioners, to administer this important public utility. This course has much to commend it, but if it be adopted it is essential that some arrangement be arrived at for ensuring thorough co-operation between the railway and the tramway authorities. A great deal has been heard lately about competition between motor buses and trams, and motor buses and trains. It has been re-

peatedly stated that if passengers are to be transported at reasonable cost it is essential that there be no duplication of services. If this applies between tramways and motor buses, is it not also applicable to the relationship of tramways and railways?

This point of the regulation of competition between tramways and railways is the strongest argument in favor of unified control by the railway commissioners. It is somewhat doubtful whether co-operation between two separate transport utilities could be arranged on a thoroughly satisfactory basis, and therefore the single control would be preferable. On the other hand experience has shown that it is not always wise to give too extensive powers to one authority, and such a method of administration may possibly lead to unsatisfactory service, through economical running being placed above the convenience of patrons. There is no doubt that there are many instances in Melbourne of duplication of services between tramways and railways, although some of these are justified by the density of loading. Nevertheless when future construction is considered this aspect must be borne in mind, and it is therefore essential that the public transport utilities be so administered that overlapping of effort will be impossible.

A further factor for consideration is the movement in favor of a Greater Melbourne council. The government is considering adding to the functions of the Melbourne and Metropolitan Board of Works, which directs water supply and sewerage in the metropolitan area, the erection of bridges and the control of arterial roads in the metropolitan area. Gradually therefore the board is becoming a sort of metropolitan governing body. The utilities it is controlling would certainly come within the province of a Greater Melbourne council. Whatever is done in regard to the tramways at this juncture, provision should be made for the possible absorption of the systems by a metropolitan council. Administration of transport by such a body would be the most logical course. Public interests would be adequately protected, and it should be possible to avoid overlapping with the railways.

Notes and Personals

Mr. F. O. Devlin has been appointed senior inspector and canvasser for the Dannevirke power board, N.Z.

Mr. G. Wilson has been appointed assistant engineer and Mr. Fielder distribution engineer to the Thames Valley power board, N.Z.

Mr. John Harrington, managing director, Harringtons Ltd., with his wife and son, left Sydney by the Sierra on April 22 on a trip to America and Europe.

The city engineer of the Sydney city council is to prepare a report on the street lighting of the city, considering the best means for improving same.

The Melbourne city council has made arrangements to increase the bulk supply taken from the electricity commission from 10,000 to 11,000 kw. The supply is delivered to the council's busbars at 6,600 volts.

At the recent Melbourne university commencement the degree of Bachelor of Electrical Engineering was conferred upon the following graduates:—R. G. Durston, E. P. Eltham, W. A. Johnson, R. B. Mair, C. P. McCarthy, A. R. Miller, W. W. Miller, G. C. B. Williams, W. L. Reilly.

Mr. P. V. Lockey has retired from the position of mains engineer to the Melbourne Electric Supply Co. after 25 years of service. At a farewell function arranged recently by the staff of the company, he was made the recipient of presentations from the various departments.

A definition of a large power house was given recently by Sir John Quick in the Arbitration Court in connection with an application by the Amalgamated Engineering Union. It states that a large power house shall be deemed to be one in which the maximum installed generating capacity exceeds 8,000 kw.

Mr. S. B. Cox, the recently appointed manager of the Adelaide branch of the Australian General Electric Co. Ltd., has been connected with the firm since 1909. He was educated and trained in England, and came to Australia in 1903 under engagement to the Brush Electrical Engineering Co. Ltd., Sydney. Later he went to New Zealand, where constructional works engaged his attention. Early in 1915 he visited the United States. He was on active service from 1915 to 1919.

The Otamatea county council, N.Z., is considering the question of electric power supplies, and has decided to have a load survey made to ascertain whether it would be possible to obtain power from Horahora or Arapuni at a reasonable rate. It is considered possible that a power board, consisting of the counties of Hobson, Otamatea, Rodney and Whangarei, with the Dargaville borough council and Warkworth town board, might be formed.

As a step towards coping with motor bus competition the city council of Auckland, N.Z., has reduced the fares on the municipal tramways. The existing rates of 2d., 3d., and 4d. will still be charged for rides of one, two and three sections, but the maximum fare will be 4d. instead of 7d. The principal reductions are in the prices

of 12-trip concession tickets. The ticket covering one section will be reduced from 1/6 to 1/4, while that for seven sections will drop from 5/6 to 3/3. The reductions will, therefore, principally affect residents outside the city area, and should tend to encourage suburban development.

An expert committee has been appointed by the N.S.W. cabinet to consider questions relating to electricity supply throughout the state, with particular attention to Sydney and its environs. Mr. O. W. Brain, assistant railway commissioner, has been appointed chairman and the remainder of the personnel is as follows:—Messrs. G. A. Julius, of Julius, Poole and Gibson; Mr. J. E. Donoghue, Electric Light and Power Supply Corporation Ltd.; Mr. Guy Allbut, city electrical engineer, Newcastle; Mr. H. G. Carter, chief electrical engineer, public works department. Mr. H. R. Forbes Mackay, Sydney city electrical engineer, was originally appointed to the committee, but declined the office.

ELECTRICAL WORKERS' BOARD, QUEENSLAND

Meetings of the board were held on March 24 and April 7. Strict inquiry is being made into further complaints regarding the performance of electrical work by uncertificated men, and a number of prosecutions for alleged breaches of the act in this respect have already been authorised. The first case came before the industrial court at Brisbane on April 7, when the employees and the employers prosecuted were each fined £1 with 3/6 costs.

Additional certificates of service without examination have been granted to two fitters, 12 mechanics, two linesmen and a joiner.

SALARIES OF MUNICIPAL ELECTRICAL ENGINEERS

The Municipal Officers' Association of Australia has prepared and circulated a new log of salaries, to apply to its members throughout Australia. The salaries claimed for electrical engineers of municipal supply undertakings are as follows:—Supervising electrical engineer, £900; electrical engineer, £750; assistant electrical engineer, £600. Under the present award the salaries of these officials vary according to the revenue of the supply undertaking to which they are attached. With revenue varying between £1,500 and £50,000 per annum, the award for supervising electrical engineer in charge varies from £364 to £676; with revenue varying between £1,500 and £30,000 the salaries of electrical engineer in charge and of assistant electrical engineer respectively vary from £312 to £468 and from £250 to £360.

When the log comes up for discussion a sliding scale, somewhat on the lines of the one at present in force, will doubtless be adopted. It is hoped to obtain from this log an award that will put municipal officers on an equivalent footing in all states.

THE SHANNON HYDROELECTRIC SCHEME, TASMANIA

The government of Tasmania having authorised the development of further power from the Great Lake, the hydroelectric department is taking steps towards the construction of a station to utilise the head at present lost on the Shannon river between the intake from the lake and the beginning of the Waddamana canal. The work is to be pushed ahead with the utmost expedition as the load demands of the island are rapidly overtaking the present supply.

Apart from the regular increase in load demand the new station will probably have to cope with special power requirements for industrial purposes. Investigations are being made with a view to establishing the pulp and paper industry in the north-west and there is a possibility of heavy loading from other manufacturing enterprises. Tenders, closing June 5, have been called for the construction and erection of an earth dam, 19 ft. high by 270 ft. long; outlet works; a canal 2½ miles long, to carry 530 cusecs of water; a concrete forebay; and 2,500 ft. of 5 ft. 6 in. steel piping, to be laid in two lines. Further tenders, closing June 30, have been called for the supply and delivery of material for an 88,000 volt transmission line, 59 miles in length, between Waddamana and Railton, with a possibility of extension over a further 31 miles to Burnie.

The head made available by the construction of the canal will be approximately 230 ft. Owing to the fact that the major portion of the head-works is already in position, functioning in connection with the Waddamana scheme, the capital cost of the new development should be fairly light. In addition the proximity of the Waddamana station makes possible considerable economy in operating costs through the adoption of automatic or semi-automatic control.

A LONG TRANSMISSION SPAN

Hydro-electric power developed in Italy is to be carried across the strait of Messina to Sicily by the most notable aerial transmission line yet planned. The distance between the towers, each of which is to be nearly 100 ft. higher than the Eiffel tower, will be two miles. There will be two circuits, each made up of three steel cables 30 ft. apart. These cables will be 4/5ths in. in diameter and will be 230 ft. above the water at the lowest point of sag.

The Performance of Direct Current Tramway Equipments

By F. Fairley*

The following notes deal with car equipment application problems which frequently arise in practice in the operation of city tramways and suburban railways. They have been abstracted from collected data and graphs, also from articles appearing in the technical press and other sources. The object is to give a lucid explanation, for easy reference, of the many variables, and their relation to each other, which form the fundamentals of car operation in everyday service.

Since actual car performance depends on so many variables which are more or less dependent upon each other, any change in one of the variables has an effect upon others. Fixed relations, however, exist between these variables. It is therefore important in making equipment applications to know the direction in which each variable tends to change on account of a change in one of the related variables.

Effects of Variation in Line Voltage

Since the speed of a series motor at any given current is directly proportional to the counter e.m.f., that is, to the impressed voltage less the resistance drop in the motor itself, the voltage at which an equipment has to operate has an important bearing on the performance of that equipment. Voltage variation affects schedule speed, energy consumption, and motor heating, but the effect on schedule speed is the most readily observed.

It can be shown that on a specific service where the accelerating and braking rates, length of run, duration of stop, and speed margin remain constant, the schedule speed, heating current and energy consumption vary in the same direction as that in which the voltage varies, but the percentage change in any one of these three variables is less than the per cent variation in voltage.

The percentage change in schedule speed due to voltage is greater with long runs than with short runs, by reason that the speed of the car before the controller is on the full parallel position depends on the rate of straight line acceleration, and is to a certain extent independent of the line voltage. On long runs the more marked effect of change in voltage is due to the fact that the motors are running at line voltage a greater part of the running time.

The percentage change in energy consumption due to change of voltage is greater with short runs than with long runs, the consumption decreasing as the voltage increases. This is because with higher voltage the car accelerates more quickly, more coasting is obtained on the longer runs, and the brakes are applied at a lower speed. The lower energy consumption is the result of less loss in the heating of wheels and brake shoes.

Heating current curves show that under any given set of conditions the percentage change in heating current is practically independent of the length of run, there being one particular

voltage for each length of run giving a minimum heating current so that the current shows a slight increase if the voltage is either raised or lowered. Low voltage, however, will often cause overheating of a motor equipment on long grades, on account of the lower speed resulting from decreased voltage. The time on the grade may become sufficiently long to exceed the motor's thermal capacity, overheat the brushes, or otherwise produce poor commutating conditions.

If service conditions are such that an equipment is able at a given voltage to make a certain length of run without coasting, it is found that an increase in voltage produces a comparatively small speed margin on very short runs, while on long runs for the same voltage increase the speed margin may be relatively great. This indicates that it is necessary for infrequent stop services to maintain better line voltage regulation or employ equipments with a greater leeway in speed than would be necessary in city service. The percentage change in schedule speed and heating current are both nearly independent of the amount of speed margin. The percentage change in energy consumption is reduced as the speed margin is increased and vice versa.

Changes in Gear Ratio

For the best results the gear ratio selected for any particular service should be such as to ensure:—

- (a) A reasonable margin for making up lost time;
- (b) That energy will not be consumed unnecessarily;
- (c) That overheating of motors will be avoided.

It is true that the maintenance of high speed interurban schedules depends largely on the gear ratio, but in city service the schedule speed is governed to such a large extent by the number and duration of stops and the rates of acceleration and braking, that the effects of gear ratio appear almost entirely in heating and energy consumption. The gear ratio gives directly the number of times the revs. per min. of the motor armature are greater than those of the car axle. When this value is large the gear ratio is said to be high. Hence the higher gear ratios produce the lower car speeds.

If the gear ratio be increased, the speed of the car at a given current will be reduced, the tractive effort at the driving wheel treads will

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be increased, and the possible rate of acceleration will consequently be increased. If the gear ratio be reduced, the speed of the car at a given current will be increased, the tractive effort at the driving wheel treads will be reduced, and the possible rate of acceleration will consequently be decreased. Thus with a low gear ratio, a larger current will be required to produce a given tractive effort and acceleration than would be required with a higher gear ratio. A frequent error in gearing is the use of a ratio lower than is necessary, resulting in an unduly large margin in speed, unnecessary heating of the equipment and excessive energy consumption.

An increase in gear ratio always decreases the rms² amps for the equipment. This means that the maximum gear reduction possible in any particular case will produce the minimum heating of the motors. It also means that gearing a car for the minimum speed consistent with satisfactory maintenance of schedule will permit the use of the smallest possible motor.

A maximum gear ratio, however, which just permits the maintenance of schedule without coasting, fails to produce the minimum energy consumption. The most economical operation is secured by employing a ratio which permits of some coasting. The reason for this is that the introduction of coasting by somewhat decreasing the gear ratio reduces the amount of energy lost in braking more than it increases the rheostatic losses.

If, however, the gear ratio is made too low, the energy consumption rises because the increased rheostatic loss overbalances the decrease in braking loss. Therefore, maximum economy in energy consumption is obtained by using the maximum gear ratio consistent with satisfactory maintenance of schedule.

An examination of curves of peak load at the car shows that the peak increases with decrease of gear ratio in approximately a straight line. Increased peaks at the car mean that the strains on the car equipment, the line drop, line loss, and peak loads on substations are increased, thus tending to decrease the load factor of the system, resulting in higher power costs. Therefore, from the standpoint of peaks, the maximum gear ratio consistent with satisfactory maintenances of schedule is best.

From the above considerations it follows that, from all standpoints, the correct gear ratio in any specific case is the maximum which insures a fair margin in speed for maintaining the desired schedule, in that such a ratio will permit the use of the smallest practicable equipment, secure minimum energy consumption, and produce minimum peak loads.

Variation in frequency of stops and consequent average length of run has a marked effect on possible schedules, heating of equipment, energy

consumption and margin for making up lost time. From curves showing the effect of length of run on heating, energy consumption and maximum schedule speed without coasting for various gear ratios, it is evident that long runs permit higher schedules with less heating and lower energy consumption than are possible with short runs and the same gearing. Also the percentage increase in schedule and decrease in energy consumption due to longer runs are greater with low than with high gear ratios, while the percentage change in rms² amps. is practically constant for a specific change in length of run irrespective of gear ratio.

It can be stated that with the same heating but different gearing a given equipment will maintain a higher schedule on long runs than on short ones. Consequently a variety of services may be adequately operated by one size of motor suitably geared in each instance. Further, when an equipment is geared for the same maximum car speed a larger motor is required for short runs than for long runs and on the short runs the schedule speed is relatively low, while the energy consumption is relatively high. This demonstrates very forcibly the penalty in motor heating, size of equipment, and energy consumption which must be paid when cars geared for high speed are used in frequent stop service.

It can be shown graphically that for a given equipment with constant schedule speed for the same length of run for each gear ratio, the heating current decreases with increased length of run, and the per cent change in rms² amps is practically independent of gear ratio. Further, the energy consumption also decreases as the length of run increases, and the percentage change due to length of run is approximately independent of gear ratio. If a constant acceleration rate is assumed the peak load depends upon gear ratio and weight (i.e., tons per motor), and does not vary with length of run.

Changes in Wheel Diameter

Changes in wheel diameter produce the same effects as changes in gear ratio, large wheels corresponding to low gear reduction, and small wheels to high gear ratios, i.e., an increase in wheel diameter is equivalent to a reduction in gear ratio, and a decrease in wheel diameter to an increase in gear ratio. Generally wheel diameter is determined by considerations other than the effect it will have on equipment, since clearances under motor and gear case must be maintained. It is sometimes found that a large wheel is of advantage in securing the minimum practical car speed which is desirable for frequent stop services.

Value of Skip Stop.

The possibility of increasing schedule speeds is the father of the Skip Stop idea. With a certain given equipment with a 4.6 : 1 gear ratio,

by increasing the average length of run from 0.1 to 0.15 mile, or 50 per cent, the schedule speed was increased 25 per cent, with a simultaneous reduction of 20 per cent in energy consumption. It would therefore seem that a careful study of traffic conditions with a view of eliminating unnecessary stops would materially assist in increasing the net revenue on many lines.

Effects of Car Weight

Another most important item in determining the duty required of an equipment is the weight of car completely equipped and loaded. This weight is usually expressed in tons per motor. The heating current, energy consumption and maximum schedule speed without coasting vary with the weight, increased weight reducing the schedule and raising the heating and energy consumption.

The decrease in schedule speed due to weight is, however, very slight with frequent stops, but is considerable on long runs if accelerating and braking rates are constant. The effect of weight on speed becomes more evident as the amount of motor curve running is increased. The effect of weight on schedule would be more apparent on short runs if the accelerating current was limited so that lower accelerating rates were obtained with the heavier cars.

A set of heating curves will show that a specific increase in weight produces a definite percentage increase in rms² amps, irrespective of length of run. Further, the percentage increase in energy consumption due to weight is greater on long runs than on short ones, but the amount of additional energy (kw. hr. per car mile) required is greater for short runs.

If tons per motor be plotted against length of run, it will be seen that, for any given increase in length of run, the percentage increase in maximum schedule speed and percentage decrease in energy consumption are less as the car weight is increased, but the percentage decrease in rms² amps is practically independent of weight.

If these curves are replotted with weights (tons per motor) as abscissae, it will be seen that with a constant schedule speed on a run of constant length the energy consumption, heating, and peak power increase with increase in weight. The percentage increase in rms² amps due to increase in weight is approximately independent of length of run and gear ratio.

On short runs for constant maximum schedule speed the percentage increase in energy consumption (kw. hr. per car mile) due to weight rises as the run is lengthened, until a point is reached where the improved equipment efficiency and reduced importance of braking losses have a greater effect than the increase in braking losses, after which the percentage increase in energy consumption due to weight decreases

as the run is lengthened. If the rate of acceleration is kept constant the peak power will of course increase with the weight.

If lengths of run be plotted against tons per motor, assuming, as before, constant schedule speed, it will be seen that the percentage decrease in energy consumption and heating due to lengthening the run is approximately independent of the weight.

Consideration of the foregoing points shows that other things being equal, minimum weight is essential to minimum motor heating, minimum size of equipment, minimum peak power, and energy consumption.

It is also well to note that reduction in weight does most to reduce the kw. hr. per car mile in frequent stop service, by reason of the fact that the watt hours per ton mile increase as stops become more frequent.

Effects of Length of Stop

Increasing the length of stop decreases both the schedule speed and the heating, such increase in length of stop producing much greater reductions in maximum schedule speed and heating on short than on long runs. Where the actual running time is unchanged the energy consumption will not be affected. When the length of stop is changed without change in schedule speed the energy consumption, heating and required equipment capacity may be affected to a considerable extent. An increase in the length of stop rapidly decreases the amount of coasting and increases the heating and energy consumption. For a specific change in length of stop the corresponding changes in coasting, heating and energy consumption (watt hr. per ton mile) are greater on short than on long runs.

Changes in Accelerating Rates

An increase in the accelerating rate always decreases the energy consumption, and the percentage decrease is greater on short than on long runs. Curves of heating current show very clearly there is a rate of acceleration between the extremes, which permits the maintenance of schedule with minimum heating. For instance the heating current for a 0.1 mile run is lower than for a 0.2 or 0.5 mile run because the time of stop (say 10 sec.) is comparatively a large proportion of the total time. It is also interesting to note that the greatest gain in percentage of coasting, due to raising the rate of acceleration, is found on runs of intermediate length rather than on either the shortest or longest runs.

Consideration of the few seconds the accelerating current is on, and the resultant mean current, both of which decrease as the rate of acceleration increases, together with the diversity obtained from the number of cars in service, demonstrates the fallacy of the impression that the adoption of a higher rate of acceleration will increase the maximum demand charge on substations.

Changes in Braking Rates

The effects of increasing the braking rate on energy consumption and percentage of coasting are similar to those accompanying an increase in rate of acceleration. The heating of the equipment, however, is always decreased by increasing the braking rate while acceleration rate and schedule speed remain constant, because less energy is wasted in the heating of brake shoes

it will be obtained by using the highest practicable rates in both accelerating and braking, but may require an equipment of unnecessarily large capacity operating with an unduly great speed margin.

Coasting

Whenever a service is run with some coasting (and all normal schedules should be so operated) a margin for making up lost time exists. This speed margin is dependent upon the amount of coasting. Hence the effect of coasting may be shown by curves plotted with the per cent speed margin against the average speed as abscissae so as to exclude the effect of stop, from which it will be seen that energy consumption, heating, and schedule are reduced as the speed margin is increased. The percentage variation in schedule speed for a specific variation in speed margin is independent of the length of run. However, the amount of speed margin has a greater effect on energy consumption and heating on short than on long runs.

Speed Margin

From curves showing the effects of schedule speed on energy consumption and heating for several lengths of run and speed margins up to 15 per cent, it can be seen that an increase in schedule speed by reducing the amount of coasting increases both heating and energy consumption, and that the effect is much greater on short than on long runs. Consequently, the most economical results, so far as energy consumption, heating, and size of equipment are concerned, are secured by operating the slowest schedule which will adequately serve and satisfy the community. Nevertheless, too much weight should not be given to this end, since at times it is more economical to sacrifice something in energy consumption, heating, or size of equipment by increasing the schedule speed so that fewer cars are required, and platform expenses reduced.

Table I shows at a glance how a change in any one of the principal variables affects others.

Motor Equipments with Field Control

For certain classes of service, and properly applied, field control equipments will show a very considerable saving in energy consumption over straight resistance control. In this system the field of each motor is wound in two parts. During accelerating on resistance both sections are used in series; this gives the motor a slow speed, high tractive effort characteristic. After the resistance is all cut out, and the motor is on full voltage, the connections are changed so that only one field section remains in circuit. This reduces the field ampere turns, and therefore the magnetic flux, and gives the motor entirely different speed characteristics.

In city or other frequent stop services the use of field control equipments shows a reduc-

Controlling Variable	Variables Affected											
	Schedule Speed	Short Length of Run	Long Length of Run	Car Speed	Rate of Acceleration	% Speed Margin	% Coasting	Heating Current RMS Amp	Motor Capacity	Tractive Effort	Energy Consumption	Peak Load at Car
Gear Ratio	I	G	L	D	I	I	D	D	I	D	D	I
Wheel Diameter	I	G	L	I	D	D	D	I	I	D	I	D
Voltage	I	L	G	I	I	I	I	I	I	I	D	D
Rate of Acceleration	I	G	L	I	I	I	I	I	I	D	I	D
Rate of Braking	I	G	L	I	D	I	I	D	D	I	D	I
Car Weight (ie. Tons per motor)	I	G	L	I	D	I	I	D	D	I	D	I
Duration of Stop	I	G	L	I	I	D	D	I	I	I	I	D
Length of Run	I	G	L	I	I	D	D	I	I	I	I	D
% Speed Margin	I				I	I	I	I	I	I	D	D
% Coasting	I				I	I	I	I	I	I	D	D
Motor Capacity	I				I	I	I	I	I	I	I	D
Schedule Speed	I				I	I	D	I	I	I	I	D

Note - "I" indicates an increase in variable
 "D" : a decrease
 "L" : that variable is affected less
 "G" : more.

Table 1.

Diagram showing for any given equipment the direction in which each variable tends to change on account of a change in one of the related variables.

and therefore less work is required of the equipment as a whole.

It can be shown that minimum practicable energy consumption consistent with minimum heating and minimum size of equipment are secured by using the highest practicable braking rate and the lowest rate of acceleration which will permit the maintenance of schedule with a reasonable speed margin. If low energy consumption is the factor of greatest importance,

tion in energy consumption of about 10 per cent over corresponding equipments with resistance control. This reduction in energy consumption is due primarily to eliminating part of the rheostatic losses on the car. The more frequently a car is required to stop, the greater will be the benefit to be derived from this source.

In suburban and interurban services where stops are less frequent the saving in energy by field control is less pronounced. Compensation, however, is often found in its ability to perform both local slow speed and through high speed schedules with the same motor and gear ratio, thus giving a greater degree of uniformity of

equipment than when different gearing or motors of different capacities are required.

The lower starting current taken by the field control motors has several advantages. The motor heating is reduced, the current taken by the car is decreased, and the peaks are of shorter duration, thus materially reducing the line drop and other losses right back to the substation. The use of the double field further affords one or more additional efficient running notches. These are of benefit in running city cars through congested sections, in climbing steep grades, rounding sharp curves, and in operating high speed interurban equipments over slow speed city lines at terminals.

Potential Conditions in Electric Tram Rails

By R. C. Philipp*

It is usual for electric tramways and many electric railways to use the track for the return current. This track, not being insulated from the earth, allows some of the current to leak into the ground and return to the substation perhaps along undesirable paths, such as pipes, buildings, etc. In order to limit this leakage and keep the greater portion of the current to the rails, the potential gradient of the rails must

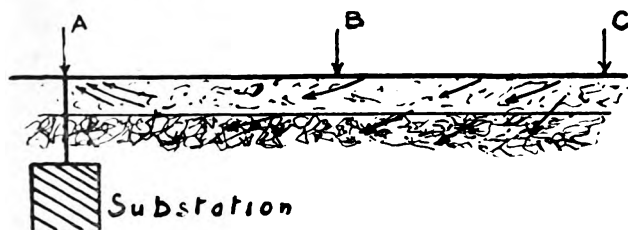


Fig. 1

be kept as flat as possible. For instance, in Fig. 1 A, B, and C represent points one mile apart along a track. The difference of potential between these points must be kept as small as possible, otherwise much of the current will leave the rails, joining them again near point A. Of course, in electric railways, the ballast has a comparatively high resistance, which helps considerably in keeping the current to the track; again, in order to shield pipes, etc., from leakage currents a bare copper cable is sometimes laid just below the track between A and say point B, but it is not proposed to discuss these aspects here.

The drop of potential is considered to be a measure of the tendency to cause stray earth currents; hence the extent of this drop is limited to whatever figure is allowed by the governing body in each particular country. The aim of the present article is to show the relation between

current, voltage drop, and the number of negative feeders necessary. The drop is taken as the average drop occurring during maximum hour loading, although it is really more logical from an electrolytic damage standpoint to take the average all day voltage drop. Of course the drop is more often actually measured than calculated, nevertheless calculations are necessary both to check the recorded measurements and in laying out a new system.

Fig. 2 shows the current and potential curves between A and B. As the current is assumed to be evenly distributed between these points (as it will be if the trams are running at regular intervals) the current in the rail will be that indicated by the line FB, it being a maximum at A and falling to zero at B. Now, if we plot a curve of the voltage between point A and successive points until we reach point B, we

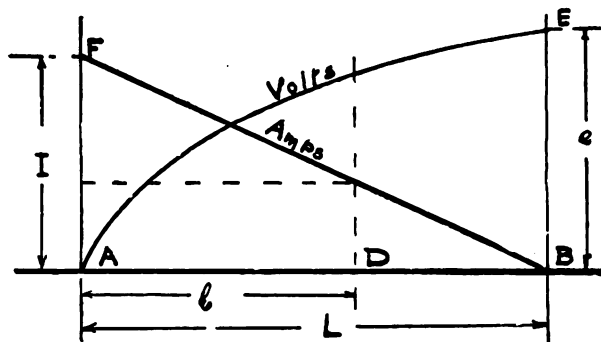


Fig. 2

get the parabolic curve AE, and not a straight line as might be supposed at first sight. The drop in volts between A and any point, D, is most clearly imagined as being the sum of the drops of two separate currents. For instance, from D there is the current fed into the section

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DB, represented by i , which has to flow back to A, and this current multiplied by the resistance AD gives us the drop da . Now considering the current fed into the section AD the whole of this obviously does not have to return from D, and so we take the average current fed between these two points and consider it for calculation purposes as concentrated at a point midway between A and D, and so this average current multiplied by half the resistance AD gives us the drop db . The sum of these two drops, da and db is the actual drop d between A and D. Evidently then to calculate these two drops we require to know the current at D and the average current between A and D.

Referring to Fig. 2, if

$$\begin{aligned} \text{Total current at A} & \dots \dots \dots = I, \\ \text{then total current at D} & \dots \dots \dots = I \left(1 - \frac{l}{L}\right) \\ \text{Total current between A and D} & \dots \dots = I - I \left(1 - \frac{l}{L}\right) \\ \text{and average current between A and D} & = I + I \left(1 - \frac{l}{L}\right) \\ & = I - \frac{Il}{2L} \end{aligned}$$

$$\text{Then drop } da \dots \dots = rl \left\{ I \left(1 - \frac{l}{L}\right) \right\},$$

$$\text{and drop } db \dots \dots = rl \left(1 - \frac{l}{2L}\right)$$

$$\text{Adding } da \text{ and } db \text{ we get drop } d = rl \left(1 - \frac{l}{2L}\right)$$

This formula enables us to plot the potential curve AE in Fig. 2.

Now, sometimes in order to keep the voltage drop per mile of rail within prescribed limits (which vary with different countries) it is necessary to have copper in parallel with the rails, though this is costly. Let us consider one or

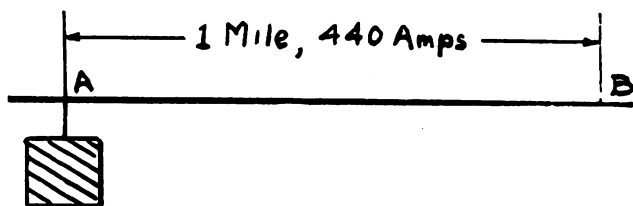


Fig. 3

two cases. The average resistance of 75 lb. rails using double tracks (i.e., 4 rails) may be taken as .016 ohms per mile, and this figure will be taken for the following examples. Let I = total current fed into rails between A and B; and R = total resistance in ohms between A and B. Now, as we have seen, the current I falls from a maximum to zero, so that the

drop could be calculated by taking the average current (i.e., half the maximum) and multiplying it by the total resistance; or, as is more usual, by imagining the total current to be concentrated at the centre between points A and B, in which case the current is multiplied by half the resistance, or:—

$$\text{Drop AB} = I \times \frac{R}{2}$$

Assuming, for example, a maximum current of 440 amps.:

$$\text{Voltage drop} = 440 \times \frac{.016}{2} = 3.52 \text{ volts.}$$

Or, given the limiting voltage drop as, say, 3.52, if it be required to calculate the current giving this drop, the above equation will naturally become:—

$$\begin{aligned} I &= \frac{\text{Volts drop}}{R/2} \\ &= \frac{3.52}{.016/2} = 440 \text{ amps.} \end{aligned}$$

If we place the substation midway between A and B we are able to double the current for the same drop, as seen in the next example, Fig. 4.

$$\text{Resistance AC} = \frac{.016}{2} = .008 \text{ ohms.}$$

$$\text{Current AC} = \frac{880}{2} = 440 \text{ amps.}$$

$$\text{Then drop AC} = 440 \times \frac{.008}{2} = 1.76 \text{ volts.}$$

That is 1.76 volts over half a mile, or 3.52 volts per mile. Fig. 5 shows the current and voltage curves over this section, and it will be seen, of course, that points A and B are at the same potential. The current is a maximum and the potential a minimum at C.

Extending Fig. 4 right and left we get the ordinary example of everyday practice of a

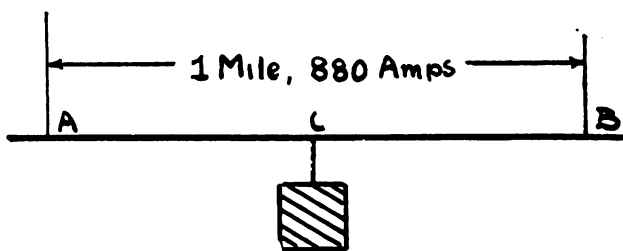


Fig. 4

central substation and negative feeders going out to points along the rail to reduce the voltage drop, as shown in Fig. 6. As the points at which the negative feeders join the rail must all be kept at approximately the same potential,

and as long feeders will have more resistance than short ones, the difference in length must be compensated for by inserting additional re-

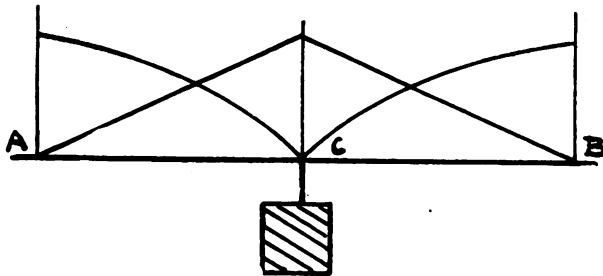


Fig. 5

sistance in the shorter ones, or by inserting negative boosters in the longer ones.

Now with regard to the spacing of these tapping points. The negative feeders are spaced along the rail at certain distances apart, depending upon the particular voltage drop per

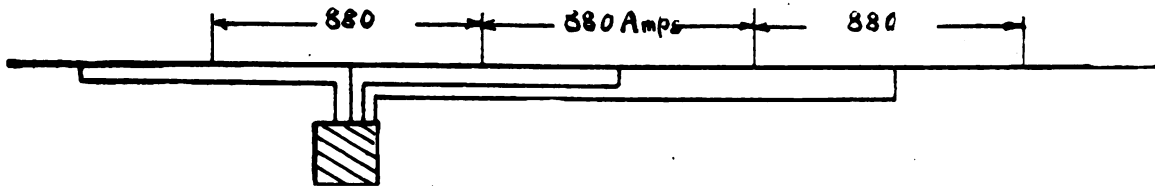


Fig. 6

mile, and also upon the actual current (for naturally the greater the current the closer will these feeders require to be spaced and vice versa). In an existing system it is sometimes found that with increasing load the voltage drop in parts of the system has become undesirably high, and it may be necessary therefore to add additional feeders, while in a new system the feeders will be spaced in accordance with the anticipated load of some years hence. To calculate the distances it is only necessary to arrive at the number of amperes per mile giving the

required voltage drop per mile. Call this current I_v and the actual load current in amperes per mile I , then the total number of negative feeders per mile = I/I_v .

Example: Volts per mile allowed = 3.52.

Line current per mile at maximum hour loading = 1,800 amps.

Resistance of tracks = .016 ohms per mile.

It is required to find the number of negative feeders per mile.

$$I_v = \frac{\text{amps. per mile giving 3.52 volts per mile}}{.004} = \frac{3.52}{.004} = 880 \text{ amps.}$$

$$\text{Then, number of feeders per mile} = \frac{I}{I_v} = \frac{1800}{880} = 2.05$$

i.e., the feeders are spaced $\frac{1,760}{2.05}$ or 857 yards apart.

It should be noted in conclusion, that in all of the above calculations it has been assumed that the whole of the current fed into the track returns by that path to the substation. As this is not so in practice*, the amount of leakage depending upon the contact resistances of the rail bonds and certain other variables which cannot be determined with accuracy, it follows that by using the above formulae the measured voltage drop will be somewhat less than the calculations give. The error of the formula, however, is on the safe side.

AUTOMATIC GENERATING STATIONS.

A contract has recently been placed with the General Electric Co. of America for the construction of the largest automatic generating station in the United States. It will be located at the Soft Maple hydroelectric development of the Northern New York Utilities Co., near Watertown, N.Y., and will consist of two 10,500 h.p. units, with the necessary transforming and switching apparatus. Its size is the significant thing about it, for until the last few years, most automatic stations did not much exceed 1,000 h.p. in capacity. The Soft Maple station is to be controlled from the Taylorville generating station, 15 miles distant, from which it will be started and stopped by energising and de-energising the transmission line. Power from the station will be transmitted at 66,000 volts.

The trend in automatic station development is clearly shown by another order for a comparatively large station of this type, also being built by the General Electric Co., for the St. Lawrence Valley Power Corporation at Potsdam, N.Y. This will be a 6,400 h.p. station consisting of two 3,200 h.p. hydroelectric units, and the energy which it generates will be transmitted at 88,000 volts. The largest type of automatic hydroelectric station at present operating is represented by the 6,500 h.p. Searsburg station on the Deerfield river in Vermont, part of the New England Power Co.'s system. This was one of the first plants to conclusively prove that the automatic station was as practicable with large-size generating units as it is with small.

*Sometimes as much as one fifth of the total current returns via the earth. See Sheldon and Hausman, "Electric Traction."

Experience of Bus Transport in Edinburgh

The controversy between the proponents of trams and motor buses for city transport still rages, and indeed is likely to remain unsettled for some time to come. Both sides advance numerous theories, but in view of the fact that there has so far been very little information made available regarding the results of actual operation of buses and trams under similar conditions, the evidence remains largely theoretical. Any details of practical operation are therefore very valuable. In an article contributed recently by Mr. R. Stuart Pilcher, engineer and manager of the Edinburgh corporation tramways, to the Commercial Motor, such details are given, and valuable conclusions drawn. The comparisons and deductions are particularly interesting to those following the developments in connection with the change-over from cable to electric traction in Melbourne, for the Edinburgh fleet was originally put into service to provide transport on certain routes during a similar change-over.

The corporation now operates 87 motor buses and 350 electric cars. The buses are built on Leyland 36-40 h.p. and A.E.C. 45 h.p. chassis, and seat 31 passengers. The fleet has been running for five years, and operating results over the last completed year are as follow:—Total receipts £132,238; bus mileage, 1,857,535; passengers carried, 18,939,780; average speed, 8.25 m.p.h.; working expenses, 15.34d. per bus mile. The present bus services consist of:—

- (1) Routes not physically suitable for operation as tramway routes.
- (2) Routes acting as feeders to the tramway system.
- (3) Routes where the traffic is too light to warrant the laying of tramway lines.
- (4) Routes of the cross-country type connecting tramway routes together.

When the buses were used for operating on the tramway routes, which were temporarily closed down, the services were as frequent as three minutes.

The revenue per bus mile was 23.07d., and the passengers per bus mile 14.82, so that the routes were, in every sense, city routes. The experience obtained clearly proves that, on these routes, the public, for various reasons, prefers electric cars to motor buses. Although the people on these routes were accustomed, previously, to an obsolete cable system, they did not take kindly to the buses. On a city route, with 1d. fares in operation, it was inevitable that crowding and congestion should take place at certain periods of the day. At these times the buses were uncomfortable, and occasionally the whole of the passengers could not be accommodated.

Another disadvantage of the buses, which was not foreseen when they were first put into service, was the delay to schedules owing to the time taken in loading and unloading. The means of entrance and exit to buses are in general not as convenient as those of tramcars, consequently the effect of the greater maximum speed of buses over tramcars is nullified by the delays at stopping places.

The result of the introduction of electric cars when the change-over was complete is rather interesting. Over a period of five weeks the number of passengers carried increased by 111,384, and over the same period the mileage run was reduced by 1,665 miles, and, in spite of the fact that the fares were greatly reduced, the revenue per car-mile was maintained, whilst the percentage of 1d. passengers to total was raised from 40.8 per cent. to 90.04 per cent. This is obviously owing to the larger seating capacity of the electric car—sixty as compared with thirty-one for the bus. Certain rush cars were removed as being unnecessary, and at busy times there was a greater number of passengers accommodated.

The modern electric cars are popular; the buses are not so popular. Some of the contributing causes of the unpopularity are being eliminated. Super-cushion tyres were introduced after a time, thus reducing the vibration, but, later pneumatic tyres were introduced, and it may be said that vibration has now practically ceased.

Several of the Edinburgh routes act as feeders to the tramway system where it would not pay to lay tramway lines. Mr. Pilcher believes that all large tramway systems have such conditions to cope with, and that there is scope for buses in this connection. If the traffic on these extensions should develop, it may pay to extend the tramway lines to cover them, but he considers that a tramway is not warranted unless at least a ten minutes' service can be run.

In considering the question of traffic congestion, there are those who think tramcars are a disadvantage. Mr. Pilcher, however, does not agree with this view. An electric car is capable of removing in the same time more people than a motor bus, and, even when a tramway system is carrying its greatest number, it cannot occupy more of the street than the line of rails. Consider what happens with the buses when they are similarly loaded; the whole street is blocked.

Experience has established that, for the number of persons carried in relation to the street space occupied, electric cars create less congestion than other forms of traffic. Thus the operations in Edinburgh seem to prove that the electric tramcar is still the leader among city transport vehicles.

The Transverter

The machine for converting alternating current into high tension direct current, displayed at the British Empire exhibition by the English Electric Co., has aroused a considerable degree of interest amongst electrical engineers. There has been much speculation as to whether the transverter, as it is called, will prove to be a commercially practicable proposition, and whether its advent marks the commencement of a new era in high tension transmission. The English Electric Journal, in a recent article, explains the principles of the apparatus, and gives a general description of the machine exhibited.

For the electrical transmission of energy over a great distance, direct current has many important advantages over alternating current, due in the main to the absence of capacity and inductive effects and to the fact that for a given effective voltage a high peak voltage occurs with alternating current which is, of course, absent with direct current. The electro-dynamic generation of direct current necessarily involves the production of an alternating e.m.f., and its subsequent rectification by means of a commutator. At the present time electrostatic machines do not appear to offer a solution, and difficulties of insulation and commutation set a limit to the pressure for which a single direct-current generator can be built.

The transverter, however, overcomes these difficulties, and although it cannot be regarded as ready for practical application at the present time, it may be of immense advantage in the not far distant future. It is in effect the equivalent of a large number of direct-current generators in series, where all the commutators have been strung on one shaft to form a single rotating unit, while the alternating e.m.f.'s are produced by a group of static transformers of special form instead of in rotating armatures. It can be readily appreciated that as the transformer windings in which the e.m.f.'s are produced are stationary, the simplest arrangement for commutation will be to use stationary commutators, and to rotate the brushes.

In the transverter, the multiplication of phases is carried out in suitable secondary windings of a group of transformers, the primary windings of which are fed from a three phase supply. The progressive phase difference between the secondaries is obtained by using a composite primary winding on each transformer core, consisting of two windings fed from two of the three phases and having their numbers of turns so proportioned as to give a resultant secondary e.m.f. with the desired phase position. In the particular transverter shown there are thirty-

six phases, and therefore eighteen cores; these are constructed in the form of three six-core units.

One complete set of the secondary windings corresponds to a two-pole two-circuit direct-current armature winding, and it is only necessary, therefore, to connect the junctions to consecutive commutator segments, and to rotate the commutator or brushes at synchronous speed to obtain a true uni-directional e.m.f. Obviously each transformer core may have a number of sets of exactly similar, but independent secondaries, so that we can obtain two, three or more closed windings, commutators and brushes all quite independent, and finally the brushes of all these commutators may be connected in series to give a total e.m.f. which is as many times greater than that of a single commutator, as there are commutators in series. To translate into terms of the actual machine shown, there are ten sets of exactly similar secondaries, and ten commutators.

It has been assumed that each commutator has the same number of segments as there are tappings from the closed series of transformer windings with which it is associated, and the brushes are diametrically opposite and are rotated at the synchronous speed of a two-pole motor fed from the three-phase alternating current mains. In order to reduce the speed of rotation of the brushes to half this, i.e., the synchronous speed of a four-pole motor, one complete set of segments occupies only 180 deg., and it is then duplicated in the remaining 180 deg.; the two brush arms are, of course, now set at 90 deg. apart instead of being diametrical.

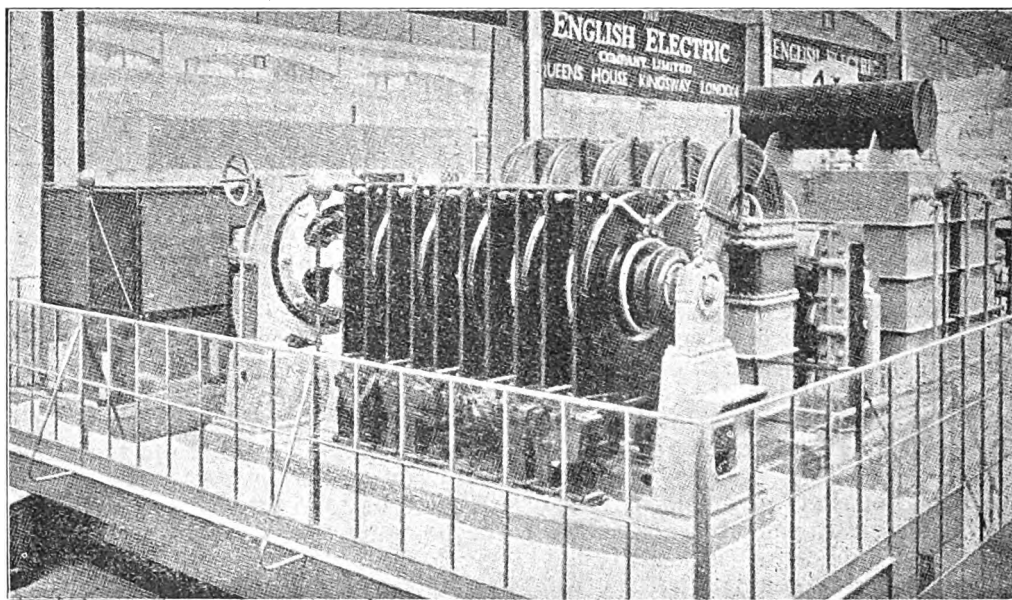
Dealing now with the construction of the transverter, as exemplified by the 2,000 kw. unit erected at the British Empire exhibition, and shown in the illustration; the transformer portion of the equipment is contained in the large casing seen at one end. This casing consists of a bedplate on which the three six-core transformers are mounted, and in the bottom of which are contained the leads from the secondary coils to the commutators. Each of the three transformer units is completely enclosed by a wrought-iron tank, and the joints which these make with the bedplate are thoroughly oil tight, so that the whole may be filled with oil.

An important detail is the orderly and symmetrical arrangement of the connections from the secondary coils to the commutator. As already mentioned, these are carried through the oil in the bedplate, where they are mounted in special racks and arranged so that the potential difference between adjacent leads is suitably limited. From the bedplate the connections

are carried vertically upward through the cast iron trunks to a special sealing section, where they are jointed to the connectors which pass to the commutator segments. Each of the ten commutators consists of a heavy panel of moulded insulating material supported on insulators secured to the bedplate. The sectors, which are hard drawn copper, are moulded into the panels, and the connections to them made on the reverse side. As already stated, the adoption of a fixed commutator presents many advantages, and gives the designer much greater freedom in dealing with the problems which result from the high voltage to be dealt with. The most important advantage, per-

the synchronous self-starting type, provided with a heavy damping winding to ensure stability and easy starting.

The particular unit is arranged for taking a three-phase supply at 50 cycles 6,600 volts and converting it to direct current at 100,000 volts. This type of plant is, however, reversible, and when direct current is fed to the commutators, it will deliver alternating current of a corresponding pressure, and at a frequency determined by the speed to which the synchronous motor is run up, by means of its exciter used temporarily as a motor. It is of interest to note that a transverter receiving a.c. and converting it to d.c. can be adjusted so as to



The Transverter at the British Empire Exhibition: Commutator End

haps, is that the commutator itself can be designed to meet the electrical requirements in the highest degree without any special necessity for great mechanical strength, such as would be essential with a revolving commutator, in order to meet the mechanical stresses due to centrifugal force.

The shaft of the revolving element is of solid steel, insulated where necessary by a suitable thickness of mica, moulded on under pressure. The insulation is of great thickness, and is arranged with discs of Bakelised paper, from which the brush carriers are supported. The brush holders are made of a light but strong alloy, and are of ample strength and rigid design in order to avoid vibration. As already indicated, the ten pairs of brushes are connected in series, so that in order to connect the end brushes to the external circuit a slip ring is necessary at each end of the brushgear system. The motor for driving the brushgear shaft is of

obtain unity power factor on the input side, thereby increasing the capacity of the generating plant, as compared with the case of transmission by a.c. At the other end of the line, assuming another transverter is installed in connection with an a.c. distribution system, the machine will supply any wattless current demanded by the load.

From the point of view of efficiency the apparatus is very satisfactory, the set exhibited maintaining a figure of over 95 per cent. on all loads between one-quarter and full load. Investigations have been made with regard to the freedom of the direct current from pulsations, and it has been found that no ripples are present. This result compares very favorably with some other forms of converting machinery, which either give rise to pronounced ripples in the d.c. voltage or cause distortion of the a.c. wave form.

Low Temperature Industrial Heating

The most efficient way in which electrical energy can be utilised is in its conversion into heat. Yet until comparatively recent times this method of using electricity has received very little attention. The tremendous inefficiency of the first conversion, that of heat into electricity at the generating station has, of course, been the factor responsible for this neglect. But now that power

importance than the consideration of actual fuel costs. The first and most obvious factor in this superiority is the efficiency of the conversion and application of electric heat, which is in general about 70 per cent, as compared to 20 per cent for various combustion devices. A second important advantage of electricity is the flexibility of its utilisation. The heat is not a product of com-

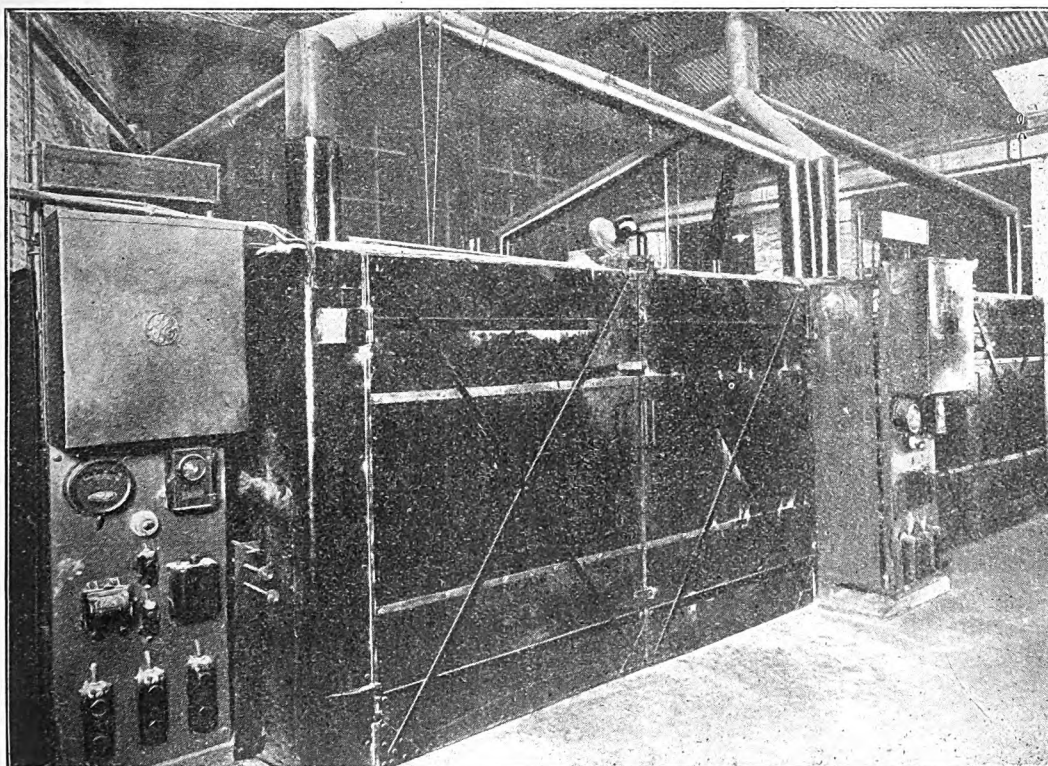


Fig 1. Enamelling Ovens at the Factory of Mess rs. A. G. Healing and Co. Pty. Ltd., Melbourne

plant efficiencies are showing steady improvement, although even under the best conditions the figure is very poor, electricity is beginning to develop into a strong competitor against the direct combustion of fuel for heat production. It must be recognised, however, that although the increased efficiency of producing electrical energy is putting it upon a better footing, it is still a long way behind other sources of heat on a cost basis at the point of consumption. This fact must be squarely faced if any progress is to be made along the lines of the utilisation of electric heating for commercial processes.

But while electrical energy cannot compete with other sources of heat on a straight-out first cost basis, it can and does exhibit marked superiority by reason of other qualities which are of greater

bustion, and may therefore be generated in any atmosphere, oxydising, neutral or reducing, and no gases are liberated during its generation. Thus electric heat may be applied in almost any situation, the source of heat itself being introduced right into the atmosphere to be heated. This is one of the factors responsible for the high efficiency of the application of electricity to heating.

The perfection of control inherent in an electric heating unit makes it very desirable in many processes where careful temperature regulation is essential. Not only can the temperature be maintained at any degree that may be required, but the same conditions may be repeated as often as desired. Electric power lends itself naturally to automatic control, and this is a very strong point in its favor. Indeed it is only automatic control

that will maintain ideal conditions, for without it the human element must always be reckoned with. This feature can effect a large saving in the cost of attendance, for an installation may be left alone with the certainty that it will continue to function. The possibility of automatic control also introduces another economy. By using a time switching arrangement an installation may be cut into service at off peak periods on the central station, thus taking advantage of the reduced price of energy at these times. In addition a time saving may be effected in certain processes by loading an electric oven during the working hours of the

of combustion, nor is the presence of oxygen necessary. The only ventilation required is that to allow sufficient air circulation for drying and carrying off the vapors arising from the work itself. The hazard of fire or explosion is entirely eliminated, thus effecting savings in material and production, as well as in property and perhaps life. More direct savings in material result from the elimination of spoilage with the electric method. There are no gases evolved which are likely to be deleterious to materials. There is absolute cleanliness, and the nicety of control obviates the risk of wrong temperatures.

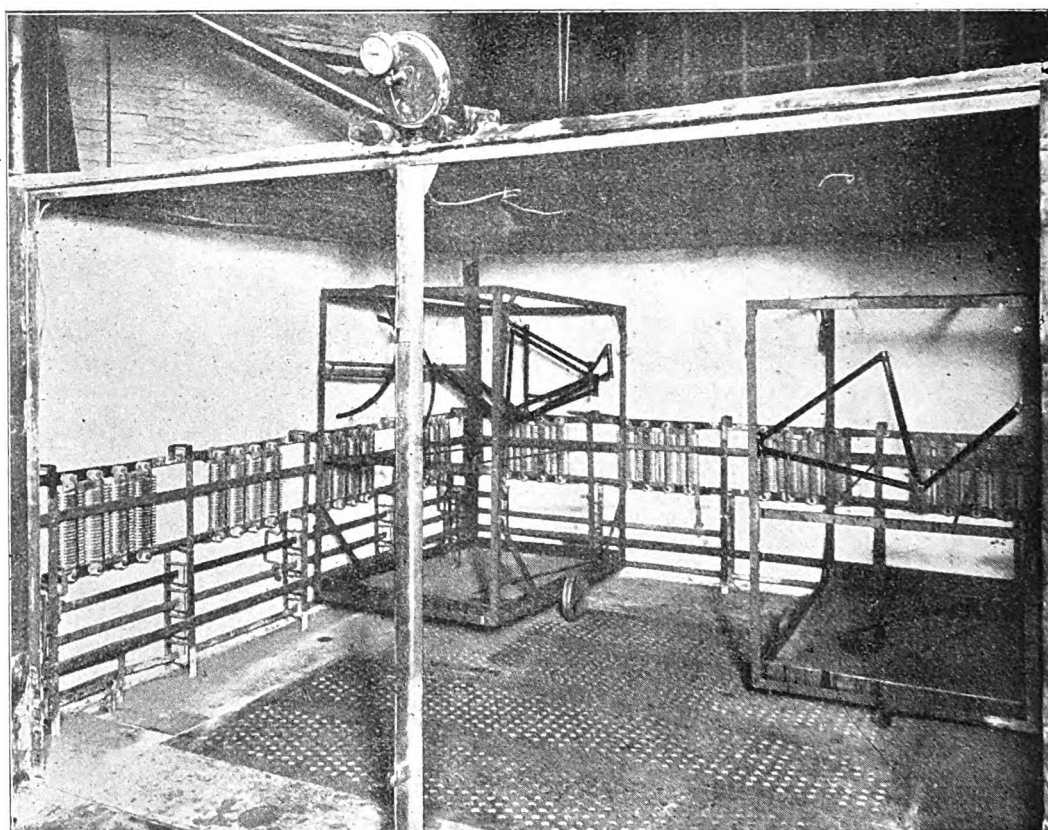


Fig. 2 Interior of Enamelling Oven showing Arrangement of Elements

day, and setting it to switch on and do the bake during the night, cutting off again automatically as required.

Low temperature applications make possible a type of unit which works at a temperature very little above that of its surroundings, thus there is no loss of heat in muffling down from a combustion temperature to one suitable for the process. Units of this nature naturally have a long life, so that the cost of repairs is negligible. A further advantage of the electric unit is its compactness and portability, which allow it to be placed in the most advantageous situations.

The ventilation of an electric oven is a comparatively simple matter since there are no products

Further advantages in an electric installation are saving in first cost, space and attendance, with a consequent saving in overhead charges. To sum up all the advantages, it has been proved in practice that the use of electricity for industrial heating gives a product of better quality than that of any other process at a considerable reduction in cost of equipment, labor and time. The crux of the whole matter lies in the fact that the cost of heat energy alone, as compared with the cost of the entire finished product, is in many instances negligible. Many items enter into the total cost of production, of which heat energy is only one. While electric heat may be the more expensive, still, if by its use the other items are cut in

greater proportion, producing greater quantity as well as improved quality, it is evident that not only is electrically generated heat cheaper to use, but also its use is imperative in order to compete successfully with those using it in similar processes.

Further refinements in methods of applying electric heat will produce further economies. Amongst these are the adoption of continuous processes, which are already largely used in many industries. For instance, the enamelling of certain automobile parts is carried out by means of a conveyor system which dips the part into the enamel, drains it, and automatically carries it through the oven, where it is baked to just the correct temperature, delivering it finished at a convenient position. The saving in cost of handling must be obvious in such a process. Again

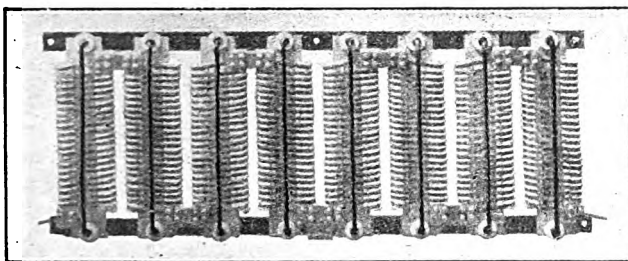


Fig. 3. Heating Unit for Electric Oven

there is now talk of a new development in which, for baking enamel on metal parts, the heat will be generated by currents induced in the metal itself. It remains to be seen whether this will offer further economies.

Typical applications of electricity to low and medium temperature heating may be seen in industrial plants in Melbourne. Messrs. Wharlington's, sheet metal workers and japanners, have three electric ovens for baking enamel. Two of them have been converted from gas and coke firing to electric heating. The dimensions of each of these are approximately 12 ft. by 10 ft. by 8 ft. high. The heating elements are arranged around the wall close to the floor, and in the floor itself, and are protected from damage by metal screens. The loading of these ovens is 52 kw. and 38 kw. respectively, and they may be worked at temperatures up to 320 deg. F. They are of the built-in type, of brick lagged on the inside with 1½ in. of asbestos compound. The ceilings and doors are of sheet iron in box form, filled with lagging compound. Automatic temperature control is used in both cases and the equipments are each fitted with a Venner time switch. The third oven was electrically heated from the outset and was installed for experimental purposes. Its dimensions are 6 ft. by 8 ft. by 8 ft. in height, and it is fitted with three wall type heating elements giving a load of 27 kw. The oven is constructed of lagged sheet iron, and is under hand control only.

At the factory of Messrs. A. G. Healing and Co. Pty. Ltd., cycle manufacturers, a new electrical installation has been put in, incorporating features which are difficult of attainment in a conversion from fuel firing. There are two ovens, each 12 ft. by 12 ft. by 6 ft. 6 in. high. They are heated by elements of similar type and arranged in a similar manner to those at Wharlington's, and the total load of each oven is 58 kw. They are used for baking enamel on cycle and side car parts, one being set apart for black work, and the other for various colors. The maximum temperatures attainable are 500 and 400 deg. F. respectively. Ventilation is provided by an adjustable intake at one side of each oven and by outlet flues in each corner. The outlets are arranged to withdraw the air by natural draft both from the top of the oven and from a level near the floor. The larger draft will naturally be from the more heated top layers, but this is compensated for by making the flue communicating with the floor layers of smaller section than the main flue and introducing it into the opening of the main flue so as to leave an annular space. The steady draft of hot air through this space draws air from the low levels through the smaller pipe by an ejector action.

In order to maintain the efficiency of any heating installation at a high level it is essential to take every precaution against loss of heat. The oven must be carefully insulated with material of the highest grade. As an illustration of the necessity of this, particularly in an electrical installation, assume an electric oven to operate at an efficiency of 80 per cent and a gas oven at 20 per cent; also assume that there are 8,000 B.th.u. required to accomplish the desired result. This means that in the electric oven the heaters must generate 10,000 B.th.u., while in the gas oven 40,000 B.th.u. must be generated. If, now, the loss is reduced by the use of proper lagging to the extent of 1,000 B.th.u. in each case, the efficiency of the electric oven increases to 8,000 divided by 9,000, or 88.8 per cent, while that of the gas oven is only 8,000 divided by 39,000, or 20.5 per cent. It is evident, therefore, that it is well worth while to use the best insulation in connection with the high-efficiency electric oven.

In designing an oven it is essential that through metal, i.e., bolts or connections communicating from the inner to the outer surfaces of the walls be kept to the minimum in order to reduce loss by conduction and radiation to atmosphere. It is also necessary to keep the mass of the walls as small as possible in order to reduce their capacity for heat absorption to a minimum. In the installation at Messrs. Healing's factory, these losses have been guarded against in the method of construction. The ovens were built on a light steel framework on which expanded metal was fastened as a support for the walls and ceiling. First quality asbestos lagging was then placed on

the expanded metal, reinforced in the outer layers by a mesh of wire netting; and the whole tar painted inside and outside. The result is that there are no through metallic contacts in the walls. All angles and metal of the framework were also carefully lagged. The only through metal in the installation is in a position where its use is unavoidable, i.e., in the frames of the doors.

The heating units of all the ovens that have been described are made up of metallic resistors in the form of nichrome ribbon wound on alundum insulators carried on steel frames. This form of heater is worked at a black temperature and has therefore a long life. The connections to the units are made by means of steel busbars. Copper is not suitable for this purpose owing to its high coefficient of expansion. The heaters at Wharing-

The thermostat is equipped with two contacts which may be set by a scale at the upper and lower limits of the temperature range required. The control relay has two separate coils which are connected respectively in series with the upper and lower contacts of the thermostat. When the temperature rises to the maximum the relay operates in the direction to open the main contactor, while when the temperature falls the reverse action takes place. The contacts of the relay are so interlocked as to cut off the current energising its coils immediately the instrument has operated, and reset the armature ready for the reverse movement. The time switch is connected in series with the control circuit so that it functions in a similar manner to the relay in energising or de-energising the closing coils of the

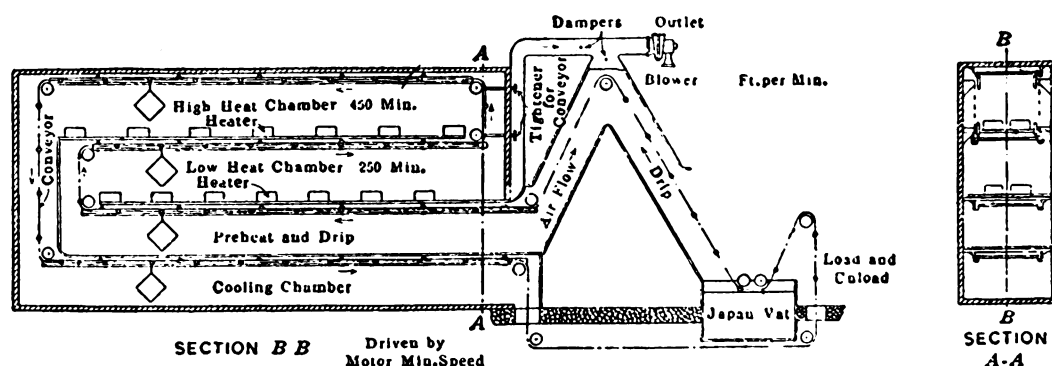


Fig. 4. Sections of Electrically Heated Conveyor Oven

ton's are supplied with direct current at 460 volts. Those at Healing's are balanced on 400/230 volt 50 cycle three phase a.c. supply. The method of control is, in its essentials, the same in each case. Each oven is equipped with an indicating thermometer for observation purposes and with a Tycos electric contact thermostat for automatic control. The controlling element of the Tycos thermostat is a thread of mercury contained in a metal capillary tube supported from the ceiling of the oven. The tube is of considerable length and is arranged in zig-zag formation across the oven so as to record the average temperature of the space. Its length ensures great sensitivity of control, while its arrangement provides for maintenance of a correct average operating temperature.

Each oven is controlled from a switch panel placed in a convenient position. In the case of the d.c. installations the equipment consists of a d.p. main contactor switch, and main fuses, a series-parallel switch for altering the arrangement of the units, a s.p. two-way control relay, control switch and fuses, thermostat, time switch and push-button station. Current for operating the relay and for opening and closing the main contactor is obtained at 110 volts from a potentiometer permanently connected across the 460 volt mains. The action of the apparatus is as follows:

The thermostat is equipped with two contacts which may be set by a scale at the upper and lower limits of the temperature range required. The control relay has two separate coils which are connected respectively in series with the upper and lower contacts of the thermostat. When the temperature rises to the maximum the relay operates in the direction to open the main contactor, while when the temperature falls the reverse action takes place. The contacts of the relay are so interlocked as to cut off the current energising its coils immediately the instrument has operated, and reset the armature ready for the reverse movement. The time switch is connected in series with the control circuit so that it functions in a similar manner to the relay in energising or de-energising the closing coils of the

main contactor. A short circuiting switch is provided with the time switch so that the latter may be cut out of action when necessary. A further feature is the provision of door contacts in series with the control circuit, so that if an attempt is made to open the oven doors while power is on the contactor will be immediately tripped. The equipment for the three phase ovens is slightly different. In place of the series-parallel switch a star-delta switch is provided for altering the arrangement of units. The contactor is of the triple pole type, and instead of a push button station for operating the control a small ironclad switch is used. The control current is obtained from a transformer connected to the mains. The use of alternating current in the control circuit has necessitated the introduction of another stage of relaying into the system. The high self induction of the trip coil circuit, coupled with the fairly large amount of energy required to operate the contactor, results in a heavy current flow in the control circuit at the moment of breaking by the relay. This naturally causes serious burning of the relay contacts. The trouble has been overcome by an arrangement whereby the relay opens the coil circuit of a small contactor, which in turn de-energises the main contactor. Thus the burning of relay contacts has been considerably reduced.

In considering the application of electrical energy to any industrial heating process it must be remembered that it is not always sufficient merely to use electrical units where fuel was used before. In other words, it is often necessary to fit the various processes of manufacturing to the use of electric heat, rather than attempt to utilise it in the present method of manufacture, in order to secure the full advantage from the change in method of heating. When manufacturing in quantity there is always one best way to perform the processes through which the work must pass. Scientific management determines and standardises this way, with the result that what has been termed the continuous method of production has

come into use. To this phase of manufacturing electrical energy is peculiarly adapted, and by its use processes may be most easily changed over from the intermittent to the continuous method. Unless such a change can be effected electrification may in many instances be a failure.

In the particular instances that have been discussed, no great changes in process have been made. Nevertheless, the introduction of electric heating has effected marked economies, and the convenience of the method has been most effectively demonstrated. Both the installations described were carried out by the Australian General Electric Co., whose principals have made a special study of industrial heating.

Decorative Highway Lighting

St. Kilda road, the principal southerly outlet from the city of Melbourne, is recognised as one of the finest thoroughfares in the world. Its total width, 198 ft., is subdivided by plantations into a central roadway, 66 ft. wide, carrying tram tracks and slow moving traffic, and



Novalux Lighting Unit, showing
Arrangement of Reflectors

two motor tracks, each 30 ft. in width. The whole is flanked by 18 ft. asphalt pavements, along the edge of each of which is a row of trees additional to those on the plantations. The trams have, up to the present, been operated on the cable system, but the tramways board is converting the system to electric traction. The poles for supporting the trolley wires have been spaced in the intervals between the plantation trees, in such positions that they do not detract from the beauty of the thoroughfare.

Increases in the volume and speed of road traffic of late years have brought about a necessity for greatly improved lighting, particularly

on main thoroughfares. St. Kilda road has been well lit according to past standards, but with the new conditions and the change-over and speeding up of the tram service it is recognised that more adequate illumination is necessary. The Melbourne city council has control of the greater portion of the thoroughfare, covering a length of about two and a quarter miles, from Princes bridge to High street, Prahran. This body has given very careful consideration to the question of providing adequate lighting, recognising that whatever scheme is adopted must not only provide efficient illumination without glare, but must harmonise with the beauty of the thoroughfare.

A scheme has now been adopted which should conform in every respect with the requirements of the situation. Tastefully designed lighting standards are to be erected at the edges of the plantations in such positions that they will not in any way interfere with the trees, and will not obtrude upon the beauty of the existing layout. Indeed the effect will be rather to add to than detract from the dignity of the thoroughfare, by day as well as by night. The units for lighting the centre roadway and tram track will be of 300 watt capacity. They will be spaced along the inner edges of the plantations at intervals of approximately 240 ft., the standards on the two sides of the road being staggered with respect to one another. Illumination for the motor tracks and pavements will be provided by a row of 200 watt units spaced at 120 ft. intervals along the outer edge of each plantation.

The installation will be supplied from three feeding points, the section nearest the city on 400/200 volt single phase 50 cycle supply, and the remainder on 400/230 volts three phase, 50 cycle. The lamps will be wired in parallel on balanced circuits, and the switching arrangements are to be such that one half of the lamps

illuminating the centre way will be cut off after midnight, leaving all the remainder alight till dawn. Four cables will be run in each plantation, one to supply the 200 watt units, one each for the halves of the 300 watt row, and one neutral cable.

The lighting units are being supplied by the Australian General Electric Co. They are all of the Novalux, form 9, eight panel design similar to those used for lighting the Church street bridge, as recently described in these columns. Each globe, including the metal fittings, is about 3 ft. 6 in. in overall height. The metal work is of cast iron, painted bronze green, and the panels are of diffusing glass, curved in conformity with the general outline of the unit. Each panel is fastened into place by spring clips against felt pads, so that the unit is weatherproof and dustproof. The metal canopy is hinged so that it may be swung back to gain access to the interior. The lamp is held in an upright position, and the light is

directed by a conical reflector in the base of the globe and a double glass Holophane dome refractor suspended above the lamp, as shown in the sectional illustration. This arrangement throws most of the light down on to the road surface, but at the same time provides sufficient side light to thoroughly illuminate the surroundings. The unit is eminently suited for artistic white way lighting and gives a very pleasant effect quite free from glare.

It is not yet certain what type of standard will be used in conjunction with these units. The council has called tenders for columns that will support the lamp centres at 13 ft. above the pavement, to be constructed either in concrete or pressed steel. The designs must be in harmony with that of the lighting unit, and it is certain nothing will be adopted that will be likely to detract from the general effect. Thus, when the work is completed St. Kilda road should be, both by day and by night, an example of the best in modern street lighting.

Moving 13,000-volt Line While Energised

In order to make room for the widening of a main road in the state of Ohio, U.S.A., an electric supply undertaking recently had to move a six mile stretch of 13,000 volt pole line to a new location parallel to the old, 10 ft. to 12 ft. back. In order to preserve continuity of supply the work had to be done while the line was energised. The poles were spaced 200 ft. apart, and each supported three wires attached to pin type insulators. It was found possible to de-energise a half-mile branch off the line, and this was used experimentally in order to determine the best and safest method of attacking the problem.

The method finally adopted involved the use of a crane mounted on a five ton truck chassis, and the procedure in moving a pole was as follows:—A labor crew would dig a hole in the new position opposite the present pole. The crane would take its position at an angle of approximately 30 deg. with the line. In some cases it was necessary to distribute blocking and lay a mat so that the crane could be kept level. When the crane was in position a hitch was taken around the pole and a sheave block placed between the boom and the hitch. This gave considerable pulling power to the hoist so that when the power was applied the pole was removed smoothly from the hole. The work was done without any swinging of the wires. The base of the pole was then carefully pushed over to the new hole while the crane was held in position. The boom was then lowered and the lineman removed the chain hitch from the pole. With two or three hitches around the

pole it was found that there was no marring or weakening of the timber. The pole was then piked into place and the earth tamped around the butt.

The foregoing operations, including the placing of the mat on which to mount the truck, the pulling of the pole and moving it to its new location, were performed in twenty minutes, considering the total time from the moment the crew started on one pole until it started on the next. However, it was impossible to move a pole every twenty minutes in the entire day on account of the detouring of the culverts which was necessary. In a great many cases it was necessary to remove wire fences, cut down hedges, etc., to get the pole in the new location. A day's work averaged sixteen poles, though in some cases a maximum of twenty-one poles were moved in a day. The normal crew on this job consisted of the foreman of the crane, an operator and helper, one lineman, one groundman, five diggers and a line foreman.

Transformer poles with equipment on them were moved about as easily, with the exception that a little care was given to attaching a guy wire at the top of the pole, owing to the fact that these poles were top-heavy. All poles were easily removed from the ground with the exception of two. In these two cases it was necessary to assist the crane by the use of jacks. An analysis of unit costs for the job, which included labor, material and hire of truck crane (£5 per day, not including operator), gave a total cost per pole of £2/4/-.—(Electrical World).

Automatic Pressure Regulators for Alternators

(Contributed)

The use of automatic pressure regulators has resulted in fundamental changes in alternator design, enabling machines of much lighter and cheaper construction to replace the heavy expensive type of alternators designed to give the smallest inherent pressure regulation. There are two distinct types of automatic pressure regulators at present in use, viz., those with vibrating contacts, and those of the quick-acting sector type. The Tirrell regulator is perhaps the best known in the former class. In the latter, a regulator displaying several points of interest has been developed by Messrs. Brown, Boveri and Co., of Baden, Switzerland.

A quick-acting regulator differs from an ordinary automatic regulator, not only in the rapid movements of the regulating mechanism, but to a greater extent in the method of regulation. Every alternator with its exciter has a certain electro-magnetic inertia, which is termed the "time constant." The magnitude of this constant depends upon the co-efficients of self-induction, and on the ohmic resistance of the field circuits of the alternator and exciter. This time constant varies between two and sixteen seconds, depending on the design and characteristics of the machine. Thus, when the excitation of an alternator is varied by a given amount, a certain time, from two to sixteen seconds, elapses before the pressure reaches the value which corresponds to the new excitation. This retarding influence of the time constant can be neutralised by making a quick-acting regulator over-regulate immediately after fluctuation of load, and then return gradually to the exact excitation current which corresponds with the new load conditions. Hunting is prevented by an elastic recall device, which breaks off the over-regulation at the right instant and starts the return movement. Practice has

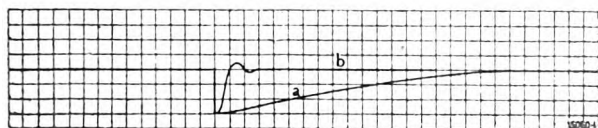


Fig. 1. Regulation Curve showing Variation of Alternator Pressure

- a. When an automatic regulator without over-regulation is used.
- b. When a quick-acting regulator with strong over-regulation and elastic recall device is used.

Abscissae: Time.

Ordinates: Pressure.

shown that vibrating contacts and suitable rolling contacts give equally good results, if the over-regulation and recall device are mutually well balanced.

Fig. 1 shows in curve a the regulation of alternator pressure for an automatic regulator without over-regulation. Curve b shows the result of using a quick-acting regulator with over-regulation and elastic recall device.

In Fig. 2 is shown the motive and regulating mechanism for a quick-acting regulator of the sector type. The single wire helices, g, which constitute the resistances are connected to heavily silver-plated contacts, l, which are arranged round arcs of a circle, about the centre of the

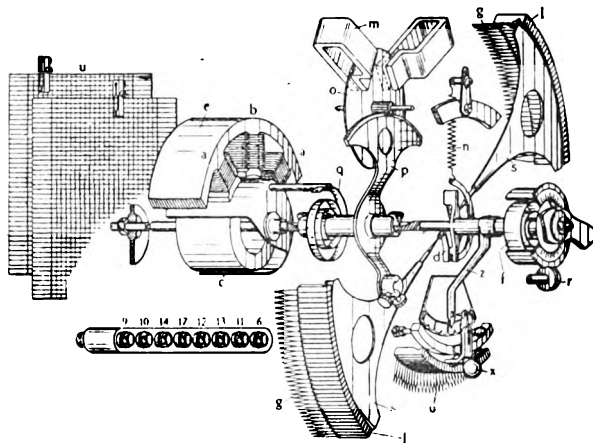


Fig. 2. Motive System and Regulating Mechanism of Quick-Acting Regulator

apparatus. According to the type of regulator two or four such sets of contacts are used. Their interior surface is grooved out to form a track in which the contact sectors, s, roll. The needle point of each sector is cradled in a jewelled cup, and is carried through a small arc of a circle when the regulating mechanism moves. The springs on which the jewelled cups are mounted are sufficiently strong to give good contact pressure between the sectors and the contacts. The counter pressure exercised on the centre is taken

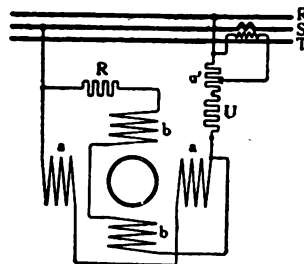


Fig. 3. Diagram of Connections of Motive System of Quick-Acting Regulator for Three-Phase Current

up by the second sector placed symmetrically with the first. Thus the movement is practically frictionless and the contact pressure is adequate and uniform.

A very slight torque is therefore sufficient to cause rotation of the contact sectors and thus variation of the excitation. The main coil, a, and the auxiliary coil, b, are connected through terminals 6 and 11 across a composed phase of the

a.c. system (Fig. 3). By means of suitable resistances, U and R, an auxiliary phase is created, and with it a rotating field. The torque exerted on the aluminium drum, c, by this rotating field is transmitted to the spindle. The latter has steel-tipped ends carried between jewels. The inner extremity of the main spring, f, is fitted to the front part of the spindle, the outer extremity being secured in a cylindrical housing which is supported by the main bridge.

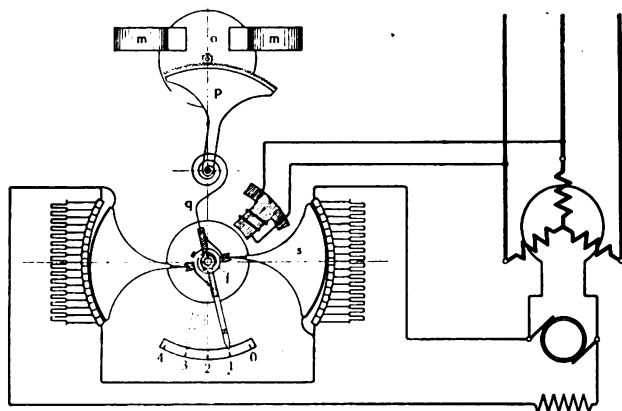


Fig. 4. Diagram illustrating Regulating Process

The auxiliary spring, which influences the spindle through the agency of a bow-shaped lever, is intended to supplement the effect of the main spring in such a way that, whatever the position the drum may occupy, a constant torque is exerted on the motive system. As a certain electromagnetic torque corresponds to each value of the alternating pressure, it is possible to set the main

motive system with a certain lag. The recall spring forms a flexible connection between the rotating drum, c, and the damping sector, p, which gears with the pinion on the damping disc, o. This aluminium disc rotates between the poles of the permanent magnets, m, which have a retarding effect on its movement.

The process of regulation may be easily followed by reference to Fig. 4, which is to be considered as purely diagrammatic. Assuming that the alternator is fully loaded, then under this condition the contact points of the sectors are so situated that the pointer, z, is about on position 1 of the scale: that is to say, the regulating resistance is nearly all short circuited. As long as the alternator pressure remains constant the torque of the drum counterbalances the torque produced by the main spring, f. This condition changes immediately if the load be reduced: the alternator pressure rises, and with it the torque on the drum, c. This torque becomes stronger than that of the spring, and produces a clockwise direction of rotation of the motive system. At first this movement is unhindered, but gradually the recoil spring is tightened between the motive system and the damping segment, which can only follow slowly. A counter torque on the drum, c, is thus produced, which brings the motive system to a stop in position 3, for example. In the meantime the excitation pressure has responded to the movement of the point of contact over the plated contacts, and the pressure of the alternator again comes to normal.

The simplicity of the recall device and the ease with which it may be adjusted, by displacing the damping magnets, allow of setting the regulator

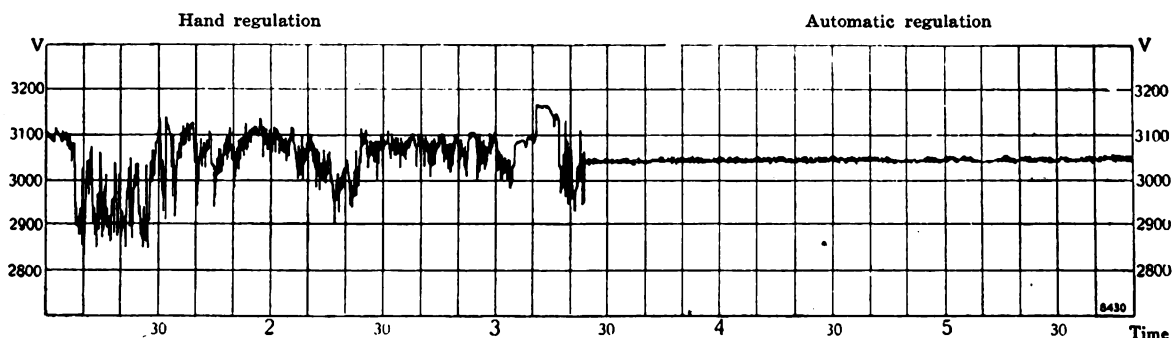


Fig. 5. Load and Pressure Curves Recorded on a Supply Station.

spring so that the two torques counterbalance each other exactly, and the motive system is in equilibrium at the pressure concerned. As a result of the very slight friction and the condition of neutral equilibrium of the motive system, quite small torques can produce considerable displacements of the contact sectors and cause strong over-regulation.

The elastic recall device used to prevent hunting consists of the recall spring, q, and a damping device, which follows the movement of the

quickly and satisfactorily for the operating conditions of machines presenting very varied electromagnetic properties.

Fig. 5 shows pressure curves at a central station before and after installing automatic quick-acting regulators. A typical regulator is illustrated in Fig. 6.

From observations taken on a number of plants in Australia, Messrs. Gibson, Battle (Melb.) Pty. Ltd., who have installed several of these regulators, state that the insensibility of the Brown

Boveri quick-acting regulator is less than ± 0.5 per cent., or, in other words, the pressure regulator intervenes as soon as the pressure has varied ± 0.5 per cent. from the desired value. In plants with relatively steady loads, the pressure can usually be kept within ± 1 per cent. As a rule the cause of considerable pressure variation is found to be insufficient speed regulation of the prime movers driving the alternators. Therefore, in some plants where very sudden and pronounced load fluctuations occur, the pressure variations may reach as high as 5 per cent.

In addition to the pressure regulation of alternators, the regulator described can be adapted to solve the following regulation problems:—Pressure regulation of d.c. generators; pressure regulation at the centre of power consumption by means of induction regulators; speed regulation of d.c. motors; power regulation with battery and booster; power regulation of electric furnaces; limiting of short circuit current of synchronous machines (current limiting regulators).

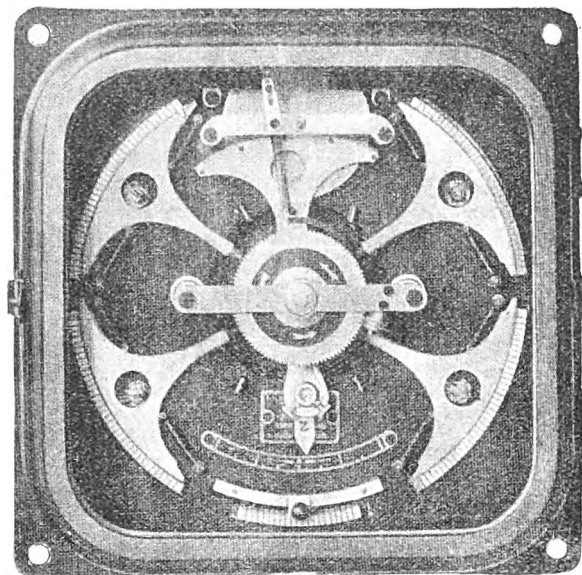


Fig. 6. Quick-Acting Sector Type Regulator

A Voltmeter for High Frequency Alternating Potentials*

By Leon T. Wilson

The voltmeter to be described was first devised in 1918 to meet the requirements of a particular problem. As then used, the instrument was primarily a laboratory one, but its usefulness in that problem was so well demonstrated that it was deemed advisable to put it into a commercial portable form. After some preliminary investigations the Weston Electrical Instrument Co. undertook the manufacture of the instrument, with the

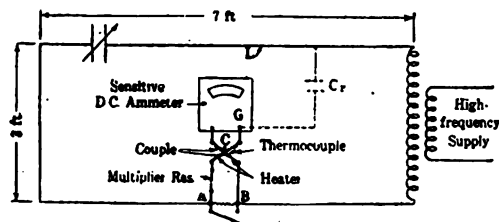


Fig. 1

been accomplished by means of special shields within the meter case and a special disposition of the component parts of the meter. Probably the theory of the new features may be presented best by first showing why the ordinary thermovoltmeter fails at frequencies above three thousand cycles, and then by following through the steps that were taken by the writer in his development of the meter to the final form which overcame the various difficulties encountered.

The specific circuit in which the voltmeter was first developed and used is shown in Fig. 1. An ordinary thermo-voltmeter is shown connected to measure the potential drop across the resistance AB. The thermocouple is shown external to the meter case, but the analysis is essentially the same as if it were enclosed. In such a circuit at high frequencies it has been found that not only does the voltmeter fail to register the true drop across AB, but it will actually give a large reading with no e.m.f. across its terminals, that is, with the resistance AB short-circuited, and again with either one of the voltmeter leads disconnected. In each case the reading was observed to increase as the meter was moved nearer the side of the circuit marked L.

Although this phenomenon appears mysterious at first sight, it is readily explained. It is due to extraneous or stray displacement currents. The principal one is that to the side of the circuit marked L because a greater difference of potential

result that there is now available a meter capable of making accurate measurements of potential at the frequencies used in radio work.

In principle the voltmeter falls in a class of instruments commonly known as thermo-voltmeters, which as ordinarily made, may be used at all frequencies up to about two or three thousand cycles. In the new voltmeter this upper limit of frequency has been increased to approximately one million cycles. This material increase has

*Paper presented before the American Institute of Electrical Engineers, Feb., 1924.

exists between that side of the circuit and the meter than between any other part of the circuit and the meter. For the present this is the only displacement current that will be considered.

Tracing now the path of this stray current. If AB is short-circuited the current will divide between the paths BC and AC. If only one lead is connected it will flow either from A to C or from B to C depending on which lead is disconnected. From C it goes to G, which is that terminal to which are connected most of the

which is in accordance with the observations. These phenomena begin to show at frequencies of about two or three thousand cycles, and explain some of the reasons why an ordinary thermo-voltmeter begins to fail at such frequencies.

The next step that was taken in the development was to enclose the ordinary thermo-voltmeter in a metallic shield, as indicated schematically in Fig. 2a, connecting the shield to the circuit at B. With this arrangement there is still a stray current from B to L but it does not now flow through the heater. Therefore when AB is short-circuited the meter is observed to read zero as it should. However a new difficulty is encountered. It is found that in measuring the drop across AB, if the leads to the voltmeter are reversed a different reading is obtained, not a common experience with an a.c. instrument. The difference in the two readings is observed to be greater the larger the instrument series resistance.[†]

To explain this phenomenon we must first observe that there is a capacity existing between G and the shield, represented by the equivalent condenser C_2 . This capacity must be taken into account in an analysis of the circuit through the voltmeter. When the leads of the voltmeter have the polarity shown in Fig. 2a the circuit through the instrument may be represented by Fig. 2b. When the leads are reversed the same circuit is represented by Fig. 2c. In both figures it is assumed that the heater and couple make contact at their respective electrical centres. Actual measurements of the resistances between terminals of the thermocouple showed this assumption to be justified.

Now comparing Figs. 2b and 2c., it is at once obvious that although the same potential be applied between the terminals A and B in each circuit, the current through the heater in each case will not be the same. This explains why the meter gives a different reading when its leads are reversed.

It will be remembered that this difference in the two readings was found to be greater the larger the instrument resistance or, stating it another way, the smaller this resistance the smaller the difference. To find an explanation for this observation it is necessary to reduce the instrument series resistance to zero and see whether the difference in readings disappears. For this to be true both circuits must reduce to an identity. They do, for they both reduce to the circuit shown in Fig. 2d. Therefore with no series resistance the meter should have its reading unchanged when its leads are reversed. This conclusion has been checked experimentally. A further study of the circuits shows that without a resistor there are equal resistances on each side of the contact between the heater and the couple, while with a

[†]This series resistance corresponds to that marked "multiplier" in the drawings.

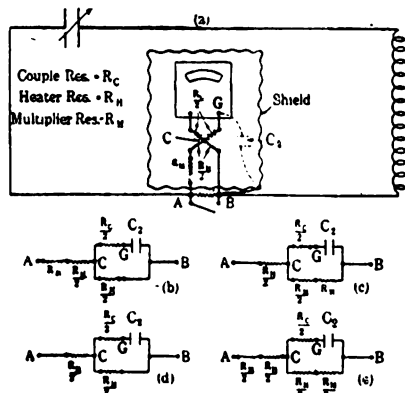


Fig. 2

metallic parts of the meter, such as the magnet, needle shield, and the like. From C it flows to L through the capacity existing between these metallic parts and the line L. Although small this capacity is very real and cannot be neglected at high frequencies. It is represented by the fictitious condenser C_1 of equivalent capacity.

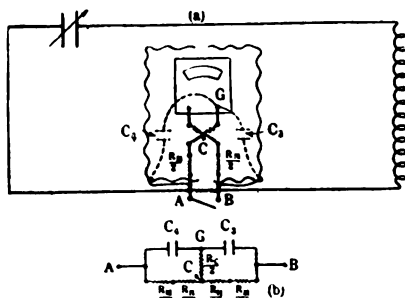


Fig. 3

It will be seen that the stray current has, on its path, gone through the heater or at least through part of the heater. The current thus causes the meter to register, and the observed phenomenon is explained. There still remains to be explained the fact that the observed reading increases as the meter is moved nearer the line L. This is due to the increase in the capacity C_1 accompanying the change in the position of the meter, which lowers the impedance of the path of the stray current and increases its value. The increased current produces a greater reading,

resistor there is more resistance on the side in which the resistor is connected. This observation at once suggests splitting the multiplier and connecting half on each lead, so as to make the resistance on each side the same. Under this condition the circuits 2b and 2c will reduce to an identity in the form shown in Fig. 2e.

Two difficulties have now been overcome. The single shield makes the meter read zero when it should. The divided multiplier makes the meter read the same on the reversal of its leads. How-

between A and B and not on the frequency, provided, of course, that the resistances have negligible inductance or distributed capacity. In practice C_3 is made equal to C_4 by a symmetrical placing of the meter with respect to the two halves of the shield, while the resistances are balanced by adjustment.

On referring again to Fig. 3b it will be seen that the voltmeter draws two distinct currents; one through the resistances and in phase with the voltage; the other through the capacities C_3

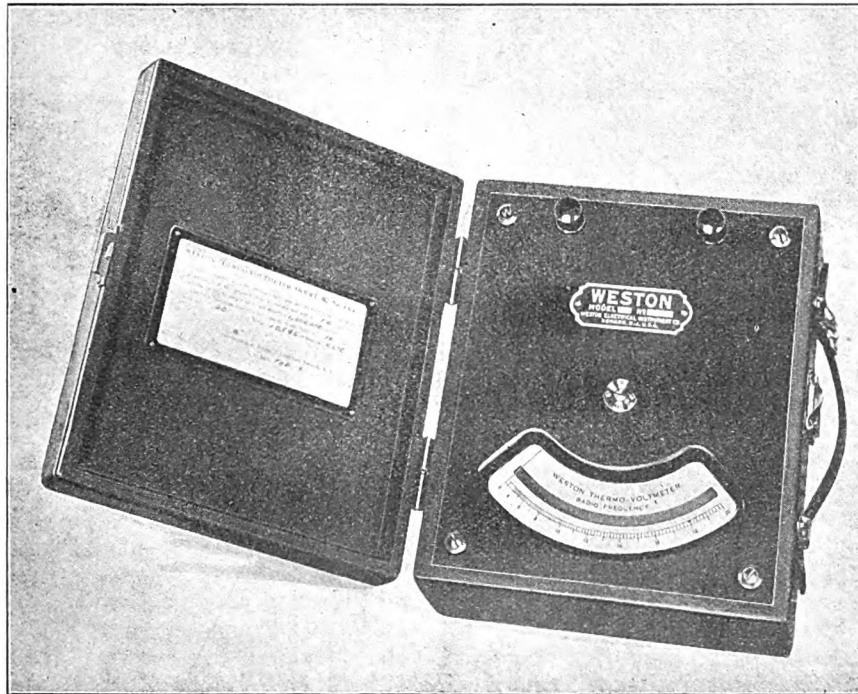


Fig. 4. Weston Radio Frequency Voltmeter

ever a closer study of Fig. 2e, shows one more difficulty to overcome. That difficulty is, that the reading of the meter is not independent of the frequency of the applied e.m.f., due to the fact that the current through the heater obviously depends on the impedance of the capacity C_2 , which is not a constant but changes with the frequency. The solution of this problem was the final fundamental step in the development of the meter to its present form. That step consists in splitting the shield, into two equal parts. One is connected to one terminal of the voltmeter; the other, to the other terminal, as shown in Fig. 3a.

An analysis of the circuit through the instrument shows that it may be represented by Fig. 3b, which has a striking resemblance to the circuit of an a.c. Wheatstone bridge. It is obviously balanced when C_3 equals C_4 and when the two resistances are equal to each other. That is, there is no alternating current flowing through $R_c/2$. When so balanced, the current through the heater resistance depends only on the potential difference

and C_1 , 90 deg. out of phase with and leading the voltage. The first current is practically the same for all voltage ranges, since the instrument resistance is proportionately greater the higher the range. The second current however is not the same for all voltage ranges. It increases with the applied voltage and also with the frequency of that voltage. This second current is small, however, and at the lower frequencies can be neglected entirely. At frequencies approaching the upper limit and particularly at the higher voltages this second current becomes appreciable and may equal or even exceed in magnitude the first current. That first current is only about two milliamperes, so in any case the total current drawn by the voltmeter over its useful range is not excessive.

In addition to the usual well known precautions necessary in high frequency measurements, it is recommended that the voltmeter be kept well away from other parts of the circuit in which it is employed, in particular those parts which are

at a widely different potential from the points to which the voltmeter is connected. Also it is recommended that in general the meter be as symmetrically placed with respect to the various parts of the circuit in which it is employed as is feasible. However, very good results have been obtained without taking any more than the usual care required in such measurements.

The Weston model is at present made in various voltage ranges from 1 to 20 inclusive. In these ranges the meter can be employed at all frequencies up to and including one million cycles with an error of less than 1 per cent of full scale value. Instruments of higher ranges can be built, of course, but it is doubtful whether they can be employed at so high a frequency with equal accuracy, on account of certain factors. For example, one of these factors is the distributed capacity of the multiplier resistance, which becomes more important the higher the voltage or the frequency.

POWER FOR THAMES, N.Z.

The Thames Valley power board has just issued a statement of the results of its working expenses and revenue, and these indicate that the board is in a flourishing condition. At a recent function to mark the completion of the major reticulation scheme a member of the board placed before the guests a number of interesting facts and figures.

Messrs. Gauvain and McLeod, consulting engineers to the board, estimated the work to cost £700,000, and this amount was raised in three separate loans of £200,000, £350,000, and £150,000. The initial foundation work was estimated to cost £514,000, but on completion a gross saving of £43,000 had been effected. During the first years' operations £95,000 had been spent, while returns over the same period amounted to only £20,000. In the second year an amount of £208,000 was spent against a trading account revenue of £36,800. Third year's expenses amounted to £167,000, and trading, £38,282. In the year just ended expenses have been £103,000; and revenue £60,000. Last year the public works department was paid a sum of £21,000 for current.

It is expected that with the expiry of the old agreement which runs out almost immediately, a reduction in the price of energy from the government will be arranged. So far no definite information is available upon the point, but in view of the fact that the minister of public works has sanctioned a reduction to the Auckland power board, it is quite probable that similar treatment will be accorded the Thames Valley power board.

THE WAIKAREMOANA AND TE REINGA POWER SCHEMES

The plans for power development in the north island of New Zealand include laying down a hydroelectric station at Lake Waikaremoana. The site is capable of development up to 100,000 kw., but up to the present the only work done has been the installation of two of the three exciters that will be required for the main plant. These machines have been temporarily coupled to three-phase alternators of 350 kw. capacity. The plant is leased to the Wairoa power board which supplies energy in bulk to the borough of Wairoa.

A good deal of criticism has been levelled at the government for its failure to carry on with the larger works at Waikaremoana, but it appears that the question of carrying on depends upon whether the Poverty Bay power board will proceed with any of the numerous schemes which have been reported upon by its consulting engineers. The Poverty Bay board originally intended to proceed with a certain scheme which was later abandoned in favor of another. Since then this second scheme has been turned down in favor of the Te Reinga Falls scheme.

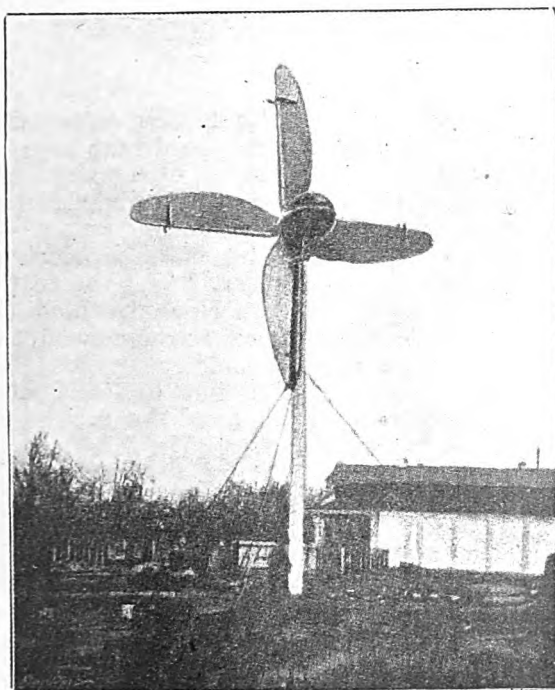
The falls are situated some 20 miles from the town of Gisborne, and are ideally situated to supply Gisborne and the surrounding district with power. The watershed supplying the river basins draining over the falls, covers an area of nearly 600 square miles. The minimum run-off is 124 cusecs, and it is intended to raise the level of the water 14 ft. when a head of 127 ft. will be available, sufficient to give 3,500 kva. The estimated requirements for the district over the first ten years rise from 800 to 3,500 kv.a.

The estimated cost of the scheme is £98,000, which is £37,000 less than that of the proposed government supply from Waikaremoana. Another important factor in favor of the Te Reinga falls scheme is the fact that the engineers have given an undertaking to have the project in working order within 18 months of the acceptance of the contract, whereas there is no guarantee of the Waikaremoana extensions being completed within the next five or six years. It has been estimated that power from Te Reinga can be delivered for less than £5/5/- per kv.a. per year, and as this price is much below the government rate there is every prospect of the board deciding upon the scheme. What the government will do in the event of such a decision remains to be seen. Waikaremoana will undoubtedly be developed sooner or later, but if the Poverty Bay board does not require its power it will probably be held up for some considerable time.

A New Wind Power Machine*

Both water and wind power have been used for many centuries through the primitive agencies of water-wheels and windmills, but whereas the developments of the last 50 years in the utilisation of water power have raised this branch of hydraulic engineering to a science in itself, methods of utilising wind power, with minor exceptions, have not materially progressed until recently.

It is interesting, therefore, to learn that a new wind power machine, which has been de-



The Aerodynamo

veloped in Germany, embodies considerable technical advantages over earlier machines, and promises to make the general utilisation of wind power a feasible proposition in places where other sources of power are not available. One of the obstacles that have hitherto hindered the development of wind power machines has been the difficulty of combining the essential factors of high efficiency and robust construction to resist any possible damage by gales. The ordinary windmill is strongly constructed, but has a very poor efficiency, and many other types of wind motor that have given greater efficiencies have not been successful in eliminating the liability to damage by high winds.

The new type of wind motor, which is known as the Aerodynamo, is designed so as to embody

the knowledge and experience that have been acquired in recent years of the aerodynamic problems relating to aeroplane propellers and resistances. The propeller of the Aerodynamo has four blades. Experiments have been made with a two-bladed propeller, but it has been found that smoother running is obtained with four blades, and a smaller span is necessary for the same power. The shape of the blades has been arrived at after considerable experimental work on various forms in a wind tunnel. The present shape is that which was found to give the greatest efficiency.

In order to transform the energy of the wind into electrical energy, a generator is geared to the propeller shaft directly, thereby avoiding bevel drives and long shafts. The generator and gearing are enclosed in a hood which is of streamline shape. A departure from previous practice is made by placing the propeller behind the generator and supporting structure. By this means the necessity of providing a guiding vane to keep the machine in the wind is avoided, and it is claimed that better efficiency is also obtained. As the machine is carried on a slender reinforced concrete pole and the generator is enclosed in a streamlined casing, any interference of these parts of the machine with the air currents is negligible.

In order to avoid excessive speeds of rotation of the propeller during high winds, patent air-brakes are fitted on the blades. These consist of small vanes (see illustration), which are held by springs of suitable strength in such a position that at ordinary speeds of rotation they offer no resistance to the air, as their planes are parallel to the direction of rotation. At higher speeds, centrifugal force causes these vanes to alter their inclination to the direction of rotation so as to offer the resistances of their plane surfaces to the rotation of the propeller. In this way a limit is placed to the maximum speed of rotation of the propeller even in the highest wind. By means of these brakes, which are not liable to become heated or to wear, damage by gales is prevented. Since aeroplane propellers are made to withstand much greater stresses than would arise in the wind motor, there is no difficulty in constructing the latter of sufficient strength, especially as the question of weight is not of such importance in a land machine as in an aeroplane. An additional brake is provided on the propeller shaft in case it is ever required to stop the rotation of the machine completely.

The reinforced concrete mast on which the machine is mounted is considerably cheaper than a lattice tower, and causes less interference with

*Electrical Review.

the air currents. In addition, it facilitates enormously the erection and transport of the machine, which can be erected or removed from one place to another in a few hours.

A storage battery is provided against the periods when there is no wind, and its size is determined by local conditions and requirements. Even in a very moderate wind, the power generated is quite considerable, as will be seen from the figures given below. Several special features are incorporated in the electrical portion of the installation. The generator, which will not normally run at above 1,200 r.p.m., is tested up to 3,000 r.p.m., in case of any unexpected failure of the brakes. An automatic regulator is also provided to prevent motoring of the dynamo by the storage battery when the wind drops. This regulator completes the circuit as soon as the voltage of the dynamo reaches that of the battery, and breaks the circuit when the voltage falls too low.

The machine shown in the illustration, which was recently tested near Berlin, has a mast 30 ft. high, and the length of the blades from tip to tip is 28 ft. The rated output is 10 kw. or 14 h.p., and the following figures give the power developed at various wind speeds at the preliminary tests:—

Wind velocity, m.p.h.	H.p.
6.5	3
11	12
18 and over	14

THE FUTURE OF THE TELETYPE

In a paper read before the Institution of Electrical Engineers, London, Mr. Donald Murray forecasted great developments in telegraphy. The instrument which is to bring about the expansion of telegraph services is the Teletype, which is a device enabling a start-stop printer to be operated by a key board similar to that of a typewriter. This will enable subscribers to communicate direct with one another, the message being typed at one end and received in printed form at the other. Such communication has apparently no distance limit, while a message could be sent and a reply received in a great deal less time than that taken by present telegraph methods. Teletype exchanges, along similar lines to telephone exchanges would be established for operating the system. It is claimed that it would be possible to send a message from England to America and receive a reply in 10 minutes.

The advantage of the system over the ordinary telegraph is obvious. It can also compete successfully with the telephone because longer distances can be covered and the messages are received in written form. In addition there is no need for an operator to stand by the receiver; the messages will come through

at any time, thus cutting out waste of time. The telephone needs two lines, but a telegraph only needs one, and in addition can work both ways simultaneously.

In the discussion following the paper a few disadvantages of the system were mentioned. Chief amongst these are the cost of the apparatus, and the possibility of "wrong numbers" being connected. Nevertheless the system appears to have great possibilities, and it is being closely investigated. Many Teletypes have already been installed in the British telegraph service and by several business concerns.

A FREE WIRING SCHEME

Owing to the unexpected closing down of a shipyard from which a large load had been anticipated the city corporation of Londonderry, Ireland, has recently found itself saddled with a considerable amount of generating plant for which it had no use. The borough electrical engineer, Mr. R. V. Macrory, has been casting about for an outlet for the current which this plant can generate, and has recommended that a free wiring scheme should be undertaken. The wiring will be carried out by contractors employed by the corporation, and slot meters will be installed in each house. The charges for energy will be so proportioned that meter rent, and interest and sinking fund on the installation will be covered. The capital for the work will be raised by a loan repayable in 10 years, and it is estimated that an additional 1½d. per unit of energy charged on the first 2,080, 1,560 and 1,040 units in the case of eight-light, six-light and four-light installations respectively, will cover all charges. On the same consumption basis ½d. per unit will provide for meter rent.

The scheme at present only contemplates dealing with premises in streets now served with distribution mains, and it is estimated that about 2,000 houses will take advantage of it. Assuming an average consumption of 200 units per house per annum the annual revenue will amount to £10,833 from sale of current and meter rent at 6½d. per unit, plus £2,500 for covering cost of wiring at 1½d. per unit, making a total of £13,333. The estimated capital for carrying out the scheme will be: £15,000 for house wiring at an average of £7/10/- per house; £7,200 for slot meters at £3/12/- each; £11,000 for services at £5/10/- each; total £33,200. It is expected that the scheme will not only result in substantially increasing the revenue of the electric supply department but will be the means of creating a considerable amount of employment and advancing trade in electrical appliances.—(Electrical Times.)

Atmospherics

Dr. R. L. Smith-Rose, writing in *World Power*, deals with the origin and nature of the atmospheric disturbances which cause interference with radio reception. A great deal of investigatory work has been carried out on the subject, with a view to arriving at the source of the trouble and devising some means of overcoming it. It is well-known that a great deal of the static which annoys the listener-in and experimenter has its origin in thunder storms. Indeed, the location of such storms may be ascer-

heating the land and causing temperature differences between the land and the atmosphere. All observers appear to agree that large stretches of sea, such as the Atlantic and Pacific oceans, are seldom the source of atmospherics.

It appears, then, that all atmospherics originate in some form of electrical discharge of a similar nature to a lightning flash. Since a visible flash is known to produce a severe atmospheric in a receiver, it is to be expected that the distance at which the electro-magnetic disturbance set up by the flash is perceptible is only limited by the insensitivity of the detecting instrument. Some very interesting researches on the wave form of lightning flashes have been carried out with a view to providing something definite upon which to base modes of preventing or reducing the interference due to atmospherics. The method adopted makes use of a cathode ray oscillograph to delineate the wave form of the e.m.f. induced in an aperiodic aerial circuit by the arriving atmospheric. The image is, of course, transient, but, due to the afterglow of the screen it may be observed visually. The wave forms are broadly typified by the graphs shown in Fig. 1. Nearly one-half of those measured were found to be of the aperiodic type as shown in Fig. 1 (a) or (b). The approximate duration of the pulse was of the order of $1/500$ of a second, and in some cases a superimposed ripple was observed as shown in Fig. 1 (c), the frequency of the ripple being from 3,000 to 30,000 cycles per second (i.e., corresponding to wave-lengths of 100,000 to 10,000 metres). The other half of the observed wave-forms were broadly of the quasi-aperiodic type shown in Fig. 1 (d) and (e), seldom comprising more than a single oscillation.

In discussing these records it has been pointed out that the relatively prolonged impulses will not account for the atmospherics experienced in wireless receivers on commercial wave-lengths. More probable is it that the short-period ripples of the type shown up in Fig. 1 (c) give rise to the disturbance, but there is naturally considerable difficulty in separating these from the main disturbance. For a given intensity of the electric field of the disturbance, and assuming a typical wave-form it has been shown that at a frequency of 16,000 cycles per second the current produced in a receiving aerial will be over 10^{137} times as great as that produced by a similar pulse at a frequency of 500 per second.

The effect of these atmospherics will therefore be quite negligible compared with ordinary commercial signals, unless the frequency is at least 20,000 cycles per second, corresponding to a wave-length of 15,000 metres. Further evidence

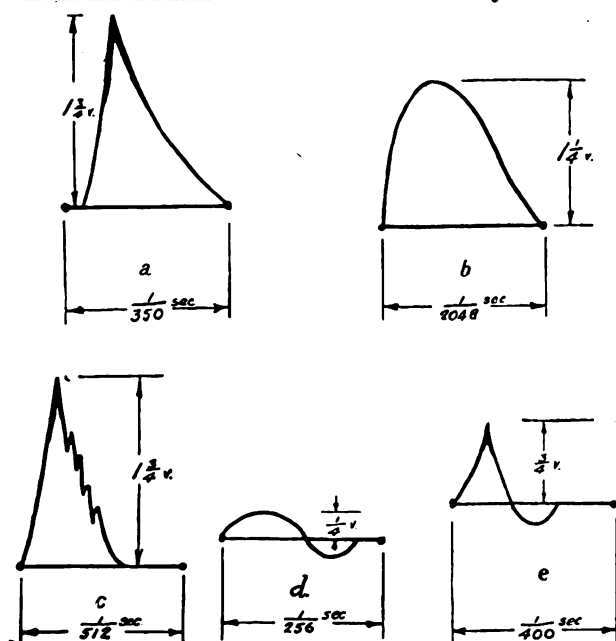


Fig. 1

tained with fair accuracy by radio direction finding up to distances of 1,500 miles, by taking from two separate receiving stations the bearing of the direction from which the disturbances emanate, and finding the point of intersection of the respective lines. But it must not be supposed that all static originates from this source. It has been found that any cyclonic disturbance or rain area will give rise to atmospherics even when thundery conditions are not definitely present. But the latest investigations show that, even when these sources are taken into consideration, all atmospherics of importance have their origin in mountainous areas. This may be due to the convection of large masses of heated air, with subsequent cooling at higher levels, causing a separation of electrical charges, the discharge of which gives rise to the atmospherics. Some relation between the altitude of the sun and the intensity and frequency of the disturbances is to be expected, on account of the effect of the radiation in

which leads to the same conclusion is obtained from the well-known fact that the strength of the atmospherics received increases with the wave-length to which the receiver is tuned.

The investigations have not yet proceeded far enough to give rise to any definite conclusions regarding methods of combating atmospherics, and there are still certain factors which have not been taken into account. The observations recorded above would infer that if there is a source of atmospheric disturbance within the range of a specific receiver that receiver will necessarily experience interference on any fairly high wave length. That this is not so is the experience of every listener-in. The sounds produced in the phones are evidently due to a heterodyne effect between the static and the carrier wave of the station to which the set

may be tuned. This is particularly noticeable in long distance working. Signals from one direction may be badly interfered with while those from another are clear, this phenomenon occurring without the use of a directional aerial. For example, a Melbourne observer may note that on certain occasions when transmission from the local stations on 1,720 and 480 metres is quite free from interference it is almost impossible to get anything intelligible from the Sydney station on 1,100 metres, and that the static does not appear until the carrier wave of the 1,100 metre station is picked up. The theories of the origin of atmospherics put forward above do not take account of phenomena of this nature, and it is therefore evident that there is still much to be done before the root of the trouble is discovered.

Wellington Municipal Electric Supply

The city of Wellington, N.Z., has of late been making extensive alterations to its electric supply undertaking. A new steam generating station, equipped with a 5,000 kw. turbo-alternator, has been laid down at Evans Bay; an agreement for taking a bulk power supply from the public works department's hydroelectric station at Mangahao has been drawn up; and the major portion of the reticulation and consumers' installations are being changed over to take 400/230 volt 50 cycle supply, instead of the 80 cycle single phase energy that has been supplied up to date. In addition the existing generating stations have been closed down, and the more modern portions of the plant are being removed to the new station; the alternators of such machines as are being transferred being replaced by generators to supply at the new voltage and periodicity. This transference of plant will bring the capacity of the Evans Bay station up to about 10,000 kw. During the work of changing over the system two 2,000 kw. frequency changers are being operated on the new supply, delivering energy to such sections of the reticulation as have not yet been tested and altered.

At the present stage of operations the load is being carried between the 5,000 kw. set at Evans Bay and the Mangahao supply. It is estimated that the maximum demand during the coming winter will be about 9,000 kw. To care for this the bulk supply will provide up to a maximum of 5,000 kw. for the present, with the Evans Bay plant making up the difference. As the load demand increases the bulk supply will be increased up to a maximum, under the present agreement, of 11,000 kw. The Evans Bay station will take care of all peak loading and act as a standby in case of emergency.

The bulk supply is taken at the public works department's substation at Khandallah, whence it is brought at 11,000 volts, through duplicate feeders, to the city. The feeders at the further end are run overhead, but on approaching the city they join up with underground cables which terminate at the Jervois quay substation. From the substation further feeders radiate to various step-down stations throughout the city. In addition to the transforming and switching apparatus there are three 1,500 kw. rotary converters at Jervois quay, also the frequency changers mentioned above. The converters supply direct current at 550 volts for the city tramways and for certain power consumers. In connection with the tramways there is a further substation at Newtown, containing a 750 kw. converter. This station is automatic in operation and requires no attendant. Two further stations of this nature are to be put down shortly, one at Thorndon and one at Karori.

The agreement under which the council takes bulk energy from Mangahao provides for a supply up to 11,000 kw. measured on a half-hour maximum demand basis at the Khandallah substation. It further states that if the council shall at any time require a supply in excess of 11,000 kw., and such supply is available, such additional power shall be supplied, and the council shall pay for all in excess of 11,000 kw. at the rate of three farthings per unit, or alternatively at the rate of £1/15/- per kw. per quarter, whichever is the lowest rate for the quarter. The public works department shall be at liberty at any time, if the demand from other consumers exceeds the capacity of the Mangahao station, to call on the council to reduce its demand within a period of one hour to the limit of 11,000 kw.

If the power factor of the council's demand on the normal daily maximum load falls below 90 per cent, the department may require the council to install within twelve months the necessary apparatus to raise the power factor to the above standard. After the expiration of any such notice properly given the charge for electricity shall, until such notice is complied with, be increased in the same proportion as the difference in percentage between the percentage indicating the reduced power factor and 90 per cent bears to 100.

The agreement provides that in cases of emergency the council shall supply to the public works department any excess energy available from the steam plant over and above the council's requirements, the department paying for such energy at the rate of 1½d. per unit. In addition the department will pay £5 to cover the cost of steam raising and preparing the plant, provided the energy is available within one hour of the department's request for supply being conveyed to the council.

In the event of the request for supply being cancelled after the expiration of the hour the department undertakes to pay for at least 1,200 units of energy.

The price which the council pays for energy under the agreement is based on the maximum demand for each quarter and is made up as follows:—For the first 200 kw. £2/10/- per kw. per quarter; for the next 4,800 kw. £2 per kw.

per quarter; for all over 5,000 kw. £1/15/- per kw. per quarter. The quarters commence on the first days of January, April, July and October. The minimum annual payments which the council undertakes to make are as follow:—

£40,000 for financial year ending March 31, 1926.

£45,000 for financial year ending March 31, 1927.

£50,000 for financial year ending March 31, 1928.

£55,000 for financial year ending March 31, 1929.

£60,000 for financial year ending March 31, 1930.

£62,500 for financial year ending March 31, 1931.

£65,000 for financial year ending March 31, 1932.

And £65,000 for each year thereafter during the continuance of the contract, provided that in the event of the amount that the department is able to supply failing for any reason to reach this value in any year, or the council's requirements failing to reach this value in any year owing to breakdowns, strikes, lock-outs, fire, earthquakes, the act of God, or acts of the enemies of the King, or by reason of any other operating factor or circumstance over which the council has no control, the guarantee shall not in such case be binding upon the council.

Suction Gas v. Bulk Supply

The borough of Palmerston North, N.Z., which has for some time been operating a suction gas driven plant of about 900 kw. capacity, is considering the best steps for ensuring a cheap and reliable power supply in the future. The Manawatu-Oroua power board has offered to supply all the requirements of the borough, but at rates which are higher than the government standard rates, and are not acceptable to the council. A conference was recently held between representatives of the council, and of the power board, presided over by Mr. F. T. M. Kissel of the public works department, in an endeavor to arrive at some arrangement satisfactory to both parties. The board purchases power from the public works department's hydroelectric station at Mangahao and proposes to sell in bulk to the council. The latter body, however, asserts that power is at present being generated in its own suction gas station at cheaper rates than those offered by the board, and that, even when provision for depreciation and reserves for future extensions is taken into account, the balance is still in favor of generation. But if the board

were prepared to supply at the standard government rates it would be more economical for the council to purchase its requirements. It has also been mentioned as a possibility that the council might purchase direct from Mangahao.

In order to substantiate the council's claim to low generating costs it was arranged that all figures relative to the plant operation were to be made available to Mr. Kissel and Mr. W. A. Waters, chief engineer to the power board. As a result of the investigation, Mr. Kissel reported that the costs per unit generated during the period from Feb. 23 to Mar. 9, 1925, were as follow:—Fuel, .355d.; labor, .455d.; oil, water, etc., .05d.; repairs, etc., .05d.; total, .91d. Mr. Kissel considers, however, that if the borough were to continue operating its plant, certain considerations would have to be taken into account which would have the effect of increasing the unit cost. Amongst these are increasing cost for repairs and fuel as the plant gets older. In addition he considers that the sinking fund provision is not high enough, as it provides for

a useful plant life of 36½ years, which is considerably more than actual experience would indicate the life of a gas plant to be. There is also the question of additions to the plant, in order to provide for a larger demand. Thus, although .91d. per unit may be a fair average cost figure under present conditions, there is every possibility of an increase in the future.

The borough council, however, is not in entire agreement with Mr. Kissel's findings, and bases its opinion on the results of a direct comparison between the costs of generation, and of bulk supply at the rates offered by the board. A test of the bulk supply was arranged, and the whole load of the borough put on to Mangahao power for a period of 64 hours under average load conditions. The cost worked out at .727d. per unit, plus .115d. per unit for switchboard attendance; total, .842d. per unit. At government standard rates the cost would have been .703d. per unit. For the three days following

this bulk supply period the generating costs of the station were recorded (unknown to the power house staff, the members of which made no endeavor to obtain special economy). These gave the following results:—Coal, .301d.; labor, .321d.; oil, .035d.; stores and water, .020d.; repairs, .008d.; total, .685d. per unit. It is certain, however, that these figures do not represent conditions that are likely to be maintained in the future, owing to the factors stated above. Nevertheless, the council considers that it will be to its advantage, and the advantage of the ratepayers, to continue generating rather than purchase bulk supplies at the rates offered. But if the board would consent to supply at the standard rates, less the discount of 10 per cent usually allowed to large consumers, the council considers that it would be to its ultimate advantage to take such supply. Accordingly an application is being made for bulk supply under the last named conditions.

WARRAGUL ELECTRIC SUPPLY

The supply of electricity to the town of Warragul, Vic., is in the hands of the River Latrobe Hydroelectric Co. Ltd., which operates a hydroelectric station in the Noojee district about 25 miles from Warragul. The plant consists of two 250 h.p. water turbines, operating on a head of about 300 ft., each driving a 190 kv.a. three phase alternator. The power is transmitted at 22,000 volts, and distribution is carried out at 400/230 volts, 50 cycle three phase. Supply is given from the transmission line to several small townships along the route. The prices charged for energy are 8d. per unit for lighting and 4d. to ½d. per unit for power. The company has had a hard fight in the establishment of its undertaking. Due largely to price increases consequent upon the war, the estimated cost of the scheme was greatly exceeded. When the state electricity commission started operations 35 miles away, at Yallourn, it endeavored to absorb the Warragul undertaking. The difficulties, however, have been overcome and the company now finds itself at the point where it should be able to make ends meet.

The state rivers and water supply commission, which controls the water resources of the state, has a scale of charges to hydroelectric undertakings for the use of water. Recognition is given to the fact that it takes some time for a supply scheme to work up to a paying basis and the charge is therefore fixed at the nominal rate of £5 per annum for the first two years of operation. After this period charges are at the rate of 5 per cent. on the gross revenue of the undertaking, with a minimum of £25. The commission has endeavored to assist the company through its difficulties by making the

charges as light as possible. The charge during the third year has been only the minimum, and the percentage has been reduced to 2½ during the fourth year. In fairness to other hydroelectric enterprises in the state, which are paying the regular rates, the commission cannot cut out the charges altogether, but it is doing what it can to encourage the Warragul company in its enterprise.

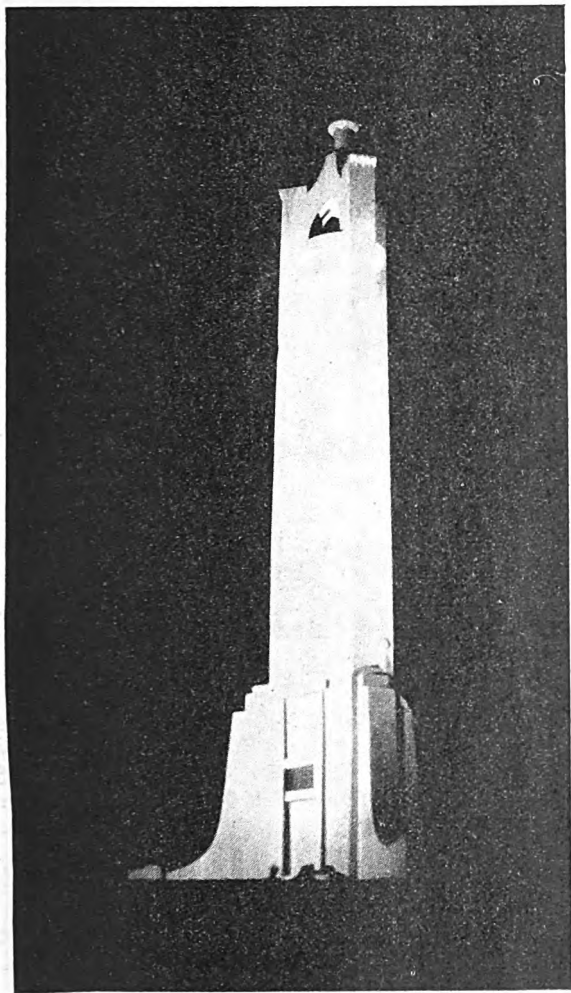
SPECIAL POWER LOAN FOR HUTT COUNTY COUNCIL

The great popularity of electricity may be gauged from the recent poll of ratepayers taken by the Hutt county council, N.Z., on the question of raising a special loan of £40,000 for the reticulation of the Makara and Johnsonville ridings of the county. The poll was attended by nearly 90 per cent of the ratepayers and only eight votes were recorded against the proposal. With the carrying of this loan, and government sanction of the scheme, the whole of the Wellington district will have been provided for under the general hydroelectric scheme. The source of power will be the government station at Mangahao, and the Khandallah substation will be the immediate distributor.

Suburban settlements on the Manawatu railway section will particularly benefit by the new loan, and one of the chief drawbacks to settlement in this area will have been removed with the installation of the electric lighting scheme. During the last few years a great volume of settlement has taken place along the Wellington-Paekakariki railway route, particularly at the seaside areas, and the price of building sections has already taken an upward turn in anticipation of the increased settlement which will follow reticulation.

A STRIKING FLOOD LIGHTING EFFECT

The citizens of Albury, N.S.W., have erected a war memorial which is a great credit to the town. It consists of a shaft of reinforced concrete, of a somewhat unusual but very dignified design, 100ft. in height, which stands on the top of a hill 300 ft. above and directly facing the main street. The fullest use has been made of the natural advantages of the site by an excellent system of floodlighting which makes the monument visible for 20 miles around by night as well as by day. In addition to



Albury War Memorial by Night

residents of the district, passengers on the trains passing between Melbourne and Sydney notice it as the most conspicuous object on the night sky.

The memorial, which will be lighted nightly, is illuminated by means of G.E. flood light reflectors mounted on steel poles 6 ft. 6 in. high set 100 ft. back from the structure. Four lamps are arranged so that two light the front face and the other two each light one of the sides. The effect is indeed striking and the

shaft appears almost translucent. The unveiling ceremony, which was performed in the evening of Anzac Day, took the unique form of bringing the light up from black out to full brilliancy by means of a dimmer, while the Last Post was sounded on the hill.

The design and execution of the illumination was carried out by the municipal electrical engineer, Mr. R. C. Creasey, and the staff of the electricity department.

STORAGE BATTERY TRAM CARS

The borough council of Gisborne, N.Z., has been operating a service of storage battery trams since 1913. The system was recently reported on by Messrs. Vickerman and Lancaster, consulting engineers, in view of the necessity of extending the transport facilities of the borough. The report recommends extension of the existing routes, the purchase of additional rolling stock, provision of more rapid and frequent service, and adherence to the present battery car system. The following estimates of the capital costs of installing alternative types of transit systems were given:—Standard trolley, £148,220; crackless trolley, £136,000; additions to present battery tram system, £101,120; petrol buses, £78,200.

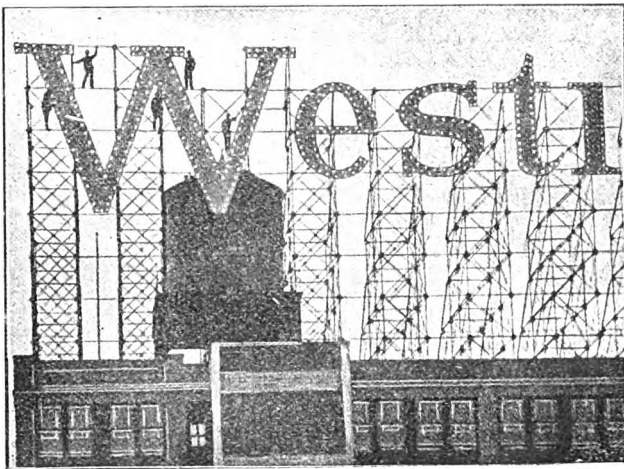
WAIRERE FALLS HYDROELECTRIC INSTALLATION

The Wairere power board, N.Z., is commencing work on its hydroelectric scheme at Wairere Falls, on the Mokau river near Pio Pio. It is proposed to develop at first some 500 h.p., but the site will allow of extensions up to 1,600 h.p. The board is extremely fortunate in having in the falls a source of power capable of successful development at remarkably small capital expenditure. At the top of the fall, which is some 60 ft. high, a ridge of limestone forms a natural dam right across the river, and produces a long stretch of very deep water, which will ensure in all seasons a constant supply for the pipe line, the head of which will take the water from a natural inlet. The pipe line from inlet to turbine will be only 150 ft. long. The natural advantages of the situation make possible a scheme so simple that the 500 h.p. plant will cost only £6,000. This capital expenditure includes the cost of automatic equipment which it is proposed to install.

It is expected that current will be available in about six months' time. Energy charges for the first one or two years will be at government standard rates, but thereafter the low cost of production should make possible material reductions. The board is raising a loan of £38,000 for carrying out its works, and its expenditure will be distributed as follows:—Generating plant, £6,000; reticulation, £22,000; assistance to consumers, £4,500; land and buildings, £2,000; preliminary expenses and interest, £3,500.

WESTINGHOUSE ELECTRIC SIGN

An electric sign, claimed to be the largest in the world, has recently been erected by the Westinghouse Electric and Manufacturing Co. on the top of its new building in Philadelphia, U.S.A. The steel structure supporting the letters is 250 ft. long and 50 ft. high, and contains about 60 tons of steel. The main portion of the sign, reading Westinghouse Electric, in two lines, is placed along the length of the building, while at one end is the familiar Westinghouse circle W. The main sign is of the continuous burning type, but the circle W is a flasher, the different parts coming on in sequence. Some idea of the size of the sign may be gained from the fact that



Portion of the Westinghouse Sign

the W in Westinghouse is 27 ft. high by 36 ft. long, and the circle of the flashing sign is 34 ft. in diameter. Approximately 5,000 Westinghouse daylight blue lamps are used to light the letters, and the current consumption is estimated to be equivalent to that for lighting an average town of 6,000 inhabitants. The building is situated in a position particularly advantageous for sign purposes. The Westinghouse message may be read from the heart of the business portion of the city and from most of the main highways and railroads in the vicinity. The sign was manufactured and erected by the R. C. Maxwell Co. of Trenton, N.J.

The marine department of New Zealand is arranging for the installation of half kw. spark transmitting apparatus at the Stephens island lighthouse and the Puyseur point lighthouse, for communication with shipping.

LAKE MONOWAI HYDROELECTRIC SCHEME

The first section of the Southland power board's hydroelectric plant at Lake Monowai has been put into operation. The power house is situated about 60 miles from Invercargill, in the south island of New Zealand, and the preliminary installation consists of two 2,000 kw. units. Provision is being made for installing four additional similar units when the demand warrants the increase. The power is transmitted by duplicate 66,000 volt lines to Winton, whence single lines run to Invercargill and Gore. Primary distribution is carried out at 11,000 and 3,300 volts, and the lines cover practically the whole of the board's area. The country areas being supplied are probably more extensive, and in some cases more sparsely settled than those of any other reticulation system in New Zealand.

NEW DEVELOPMENT AT LAKE COLERIDGE, N.Z.

The new development work at the government station at Lake Coleridge is being pushed on rapidly and during the month of April over 200 men were employed on the various sections. In connection with the new tunnel, concrete lining has been carried up to the end of the excavation at the intake end, and pumps installed to cope with the water encountered in the face. At the outlet good progress is also reported. The placing of concrete in the surge chamber and the pipe tunnels has been commenced, and about 140 yards of concrete are now in position. All the anchor blocks for the pipe line are complete to the invert, and the supporting piers below the No. 2 anchor block are finished. Work has been commenced upon the tail race, while the assembly of the drag-line excavator is now complete. The walls of the power house extension have been raised another few feet and are now almost to the level of the generator room roof.

The construction of the steel caisson by the Dunedin Engineering Co. Ltd., is nearly completed, and the lower length is being floated out ready for testing. In connection with the subaqueous tunnel the excavating and lining have been carried on by a party working under the co-operative contract system, and the results have been entirely satisfactory to date. The tunnel has been excavated for a distance of 120 ft. and lined with concrete to the 80-ft. mark.

Radio News

The death is reported of Mr. G. C. Isaacs, who recently retired from the managing directorship of Marconi's Wireless Telegraph Co. Ltd., London.

Mr. C. D. Maclurcan, president of the Wireless Institute of Australia, N.S.W. division, has presented a cup for perpetual competition, with the object of encouraging the development of wireless by amateurs.

The following gentlemen have been elected to the executive council of the Wireless Institute of Australia, N.S.W. division, for the ensuing session:—Messrs. P. Renshaw, F. Stowe, C. D. Maclurcan, F. Marsden, O. Mingay, —. Perrett, and B. Cooke.

The Wireless Institute of Australia, N.S.W., division, has arranged for the transmission each Tuesday night, from station 2CX, Mr. H. A. Stove, Chatswood, N.S.W., of a series of standard calibrating signals covering a range from 60 to 250 metres.

The Victorian section of the Wireless Institute of Australia is holding its annual wireless exhibition in Melbourne from May 20 to May 30 inclusive. The co-operation of dealers and experimenters has been enlisted and it is hoped to have a very comprehensive and interesting display.

An excellent long distance communication performance has been put up by Mr. B. J. Masters, a Victorian experimenter who has been in touch with an American amateur in Iowa. Mr. Masters' transmitter employs two 5-watt transmitting valves and operates with an aerial the maximum height of which is only about 30 ft.

The annual dinner of the N.S.W. division of the Wireless Institute of Australia was held in Sydney on April 30. Mr. C. D. Maclurcan, who presided, forecasted that the coming year would be even more successful than the last. He stated that arrangements had been made with the government to subsidise the institute pound for pound up to £1,000, thus encouraging research work.

The Union Co.'s mail steamer Niagara has established a new record in long distance ship communication by maintaining touch with Sydney throughout the whole of the voyage to Vancouver. The transmitter used was installed by Amalgamated Wireless (A/sia) Ltd. and worked on a short wave length in conjunction with special equipment at the Pennant Hills commercial station.

The international wireless congress meeting in Paris has approved of a series of recommendations that specific wave lengths for short wave inter-

national working be assigned to amateurs in different regions with a view to obviating confusion. The following wave lengths have been suggested: Europe, 115 to 95, 75 to 70, and 47 to 43 metres; Canada, 120 to 115, 46 to 41.5 metres; United States, 85 to 75, 41.5 to 37.5 metres; Rest of the world, 96 to 85, 37.5 to 35 metres.

Some interesting short wave experiments are to be undertaken by members of the Australian Inland Mission during an extensive trip through central Australia. Rev. John Flynn and Mr. R. Towns have been supplied with a low power transmitter and receiver for use on wave lengths below 100 metres, and will investigate the possibilities of regular communication from the remote districts which they will visit. Leading experimenters throughout the Commonwealth are arranging to maintain a definite schedule of communication with the inland station during the trip. There is little doubt but that some important and useful experimental work will be possible.

Mr. C. D. Maclurcan, of Strathfield, N.S.W., has succeeded in getting into direct communication in Morse code with Mr. W. E. Simmonds, of Gerrards Cross, England, during daylight. The wave length used was 20 metres and the power 55 watts. Attempts are now being made to establish telephonic transmission over the distance in daylight, by the use of ultra short waves. In a recent experiment in this direction, Mr. Maclurcan succeeded in getting into touch with a Japanese operator in Tokio, with whom he was able to carry on a two-way conversation.

Mr. F. W. Stevens, who has been appointed chief engineer of the Queensland state radio station, has entered upon his duties in Brisbane. He commenced his wireless career in the postmaster-general's department, and during the war served on transports. Then he had tropical service at coastal radio stations, and afterwards was attached to the meteorological station at Willis Island, off the North Queensland coast. He was a pioneer of broadcasting in Australia, being first connected with 2FC in Sydney, as assistant engineer. Afterwards he joined 3LO, Melbourne.

MELBOURNE BROADCASTING STATION ON NEW WAVE LENGTH

The postmaster general's department has granted the application of the Broadcasting Co. of Australia Ltd. for permission to reduce the wave length of its station, 3LO, Melbourne. Hitherto a wave length of 1,720 metres has been used, but the new wave length will be 371 metres. It is expected that a very considerable increase in received signal strength will result from the use of this new frequency, thus increasing the range for effective crystal reception. The new wave

length has been selected with a view to minimising risk of interference with existing stations. The wave length of the other Melbourne station, 3AR, is 480 metres, which shows a difference of 190 kilocycles from the 371 metre length. Those who appreciate the fascination of interstate working may possibly be alarmed at the apparent proximity of the new wave length to those of other stations such as 2BL, Sydney, on 350 metres. When certain readjustments have been made, however, the kilocycle difference will in no case be less than 50, so that there should be no fear of interference provided the tuning of the transmitters is reasonably sharp. The difference between 6WF, Western Australia, on 1,250 metres, and 2FC, Sydney, on 1,100 metres is only 32 kilocycles, but each station can be heard by those with the necessary long range apparatus without interference from the other. 3LO will change over on to the new wave length as soon as the necessary alterations to the equipment are complete.

Telephony and Telegraphy

COMMONWEALTH P.M.G.'s DEPARTMENT Operations during April

New South Wales.—Two additional trunk circuits have been completed, the principal towns affected being Garah, Mungindi and Neworra. The existing trunk line between Garah and Mungindi was also made metallic, and the Ingleburn to Campbelltown section of the Sydney to Campbelltown trunk circuit was completed.

Sixteen country public lines were erected, providing facilities for 32 centres, and 12 new exchanges have been opened. Additional exchange equipment has been installed at 11 centres, approximately 660 extra services being provided for. Additional telegraph circuits have been completed between Campsie and Lakemba, and also the Sydney to Ingleburn section of the Sydney to Canberra telegraph circuit.

In the country 3 m. 144 yd. of 4 in. E.W. pipe were laid, 6 m. 522 yd. of cable ranging from 15 to 300 pairs were laid, and 8 m. 1,591 yd. of cable ranging from 10 to 312 pairs were jointed, the approximate conductor length of cables laid and jointed being respectively 553 m. 465 yd. and 757 m. 1,149 yd.

In the metropolitan area 4 m. 1,001 yd. of 100 pair cable were jointed, the conductor length jointed being 456 m. 1,450 yd. Semi-automatic exchange equipment was installed at Edgecliff, which enables incoming traffic to be received by Edgecliff subscribers without the intervention of a telephonist.

Victoria.—Thirteen additional trunk circuits have been completed, the principal towns affected

being Ringwood, Warrandyte, South Warrandyte, St. Arnaud East, Gower East, Waanyarra Rush, Green Gully, Kurting, Roslynmead, McEvoys, Piavella, Warracknabeal, Brim, Murtoa, Hope-toun, Warrnambool, Purnin, Colac, Beeac, Ballarat, Buninyong, Ararat, Langi Logan, Morroona, Rossbridge, Willaura, Stavely and Glenthompson.

Nine country public lines were erected providing facilities for eleven centres.

Additional exchange equipment has been installed at 8 centres, approximately 640 extra services being provided for.

Approximately 1,142 yd. of cable ranging from 10 to 75 pairs were laid, the conductor mileage of cable laid being approximately 45 miles.

New exchanges have been opened at 23 centres and new switchboards fitted at 20 country offices, approximately 280 services being provided for.

In the metropolitan area 3½ m. of 4 in. E.W. pipe were laid, and approximately 6¼ m. of cable ranging from 5 to 800 pairs were drawn in, the conductor mileage of cable drawn in being approximately 3,541½ miles. Additional exchange equipment has been installed at Malvern and Frankston, approximately 200 extra services being provided for.

New automatic telephone exchanges have been opened at Ascot and Carlton in the Melbourne suburban area. About 4,000 subscribers who had been connected to the Ascot and Central manual exchanges were cut over on to the new equipment on May 9.

Queensland.—Five additional trunk circuits have been completed, the principal towns affected being Rockhampton, Mackay, Emerald, Longreach, Alpha, Jericho, Barcaldine, Ilfracombe, Aramac, Muttaborra, Winton, Blackall, Alice, Isisford, Tambo, Gydia, Smiths' Lagoon, Ventry, and Hilliers.

New offices have been opened and telephonic facilities provided at 6 centres, and additional exchange equipment has been installed at 15 centres, approximately 270 extra services being provided for. Additional trunk equipment has also been installed at Innisfail, Atherton and Cloncurry.

In the metropolitan area an additional trunk test desk has been installed at Central.

South Australia.—Three country public lines were erected, providing facilities for Cauramouth, Purnong, Black Springs, Farrell's Flat, Yalata, and Sturdee.

In the country, 4 m. 1,518 yd. of single duct conduit were laid, and approximately 4 m. 154 yd. of cable ranging from 25 to 50 pairs were drawn in and jointed, the approximate conductor length of cable drawn in and jointed being 178 m. 440 yd. Additional exchange equipment was installed at 5 centres, approximately 160 extra services being provided for.

Western Australia.—One additional trunk circuit has been completed, the principal towns affected being Bridgetown, Winnijup and Mayanup. Considerable progress was also made with the erection of long distance trunk lines, principally radiating from Perth to the larger country centres.

Five country public lines were erected, providing facilities for 7 centres, and one additional telegraph circuit has been completed between Onslow and Point Beadon.

Additional exchange equipment was installed at Mingenew, Dowerin, and Korrelocking, approximately 170 additional services being provided for.

Tasmania.—Two additional trunk circuits have been completed, the principal towns affected being Scottsdale, Branxholm, Hobart, and Gretna.

Two country public lines were erected, providing facilities for 5 centres, and new exchanges were opened at Alonnah, Egg Lagoon and Judbury, approximately 20 services being provided for.

Trade Notes

Electric Insulators Ltd., with authorised capital of £5,000, has been registered in Sydney, to carry on business as dealers in stone, sand, vulcanite, glassware, porcelain, pottery, etc., and as electricians and mechanical engineers. First directors are: W. E. Clegg and A. Whitehouse.

Voltmeter for Radio Frequency Potentials.—A description is given on another page of the new radio frequency indicating voltmeter developed by the Weston Electrical Instrument Co. Messrs. Warburton, Franki Ltd., of Melbourne and Sydney, are agents for Weston instruments and will be pleased to quote prices and give any further information regarding the new meter.

Overseas Price List.—Messrs. Cargills Ltd., London, have issued a current price indicator which should prove of considerable value to importers and wholesale supply houses. It is not intended to be taken as giving direct quotations for the large assortment of electrical fittings and apparatus listed, but as its title suggests, is an indicator of present price levels. The list will be issued periodically and is obtainable on application to Messrs. Cargills' representatives in the various cities of the Commonwealth and New Zealand.

Power Plant for Coal Mines.—Caledonian Collieries Ltd. are about to erect a new power station at Cockle Creek, near Newcastle, N.S.W., to supply energy for operating their pits. Contracts have been placed with Messrs. Gibson, Battle Pty. Ltd. for supply of two 5,000 kw. Brown Boveri turbo-alternators, Messrs. Babcock

and Wilcox for two 54,000 lb. per hr. boilers, and the English Electric Co. for supply of switchgear.

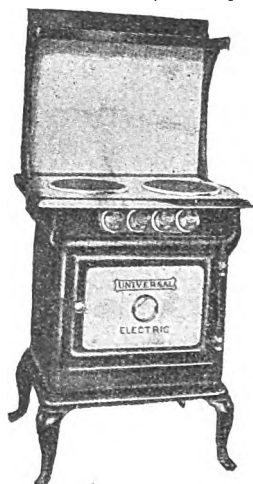
Acid-Proof Motors.—Messrs. Noyes Bros. (Melb.) Pty. Ltd. have been awarded a contract to supply 25 acid-proof three phase motors in capacities ranging from 6 h.p. to 75 h.p. to the Mt. Lyell Chemical Works, Yarraville, Vic. The motors are to be manufactured by Messrs. Parkinson (Aust.) Ltd. in Sydney. This firm's standard motor specification complies in most respects with the special conditions called for. The motors will be of the open type, each fitted with a ventilating fan. The specification states that all winding wires are to be treated with a bituminous compound, and the stators as well as the rotors are to be twice dipped in insulating varnish.

A.G.E. Exhibit at Sydney Show.—The Australian General Electric Co. had an attractive exhibit at the Easter show of the Royal Agricultural Society of N.S.W. It was designed principally to display the various applications of electricity in the home and to show how power could be made available even in remote parts of the country. The various domestic applications included Hotpoint stoves, the Premier vacuum cleaner, Walker dishwasher, Hurley clotheswasher, and such small apparatus as Hotpoint irons, grillers and kettles. For making electric energy available at the out-back homestead the G.E. home light and power unit was exhibited. It consists of a $3\frac{1}{4}$ h.p. kerosene engine direct coupled to a $1\frac{1}{2}$ kw. generator, and is supplied with a 213 amp.-hour battery. A pulley is provided so that the set may be used in addition to supplying electrical energy, as a mechanical power unit. The outfit requires no supervision, and is equipped for automatic stopping when the battery is fully charged. In addition to all the devices designed to provide for the comfort and convenience of the farmer and the housewife, the stand exhibited material for recreation, in the shape of a fine assortment of radio apparatus. This section included B.T.H. loud speakers, Radiotron valves, and all the usual equipment. The whole exhibit was very attractive, and excited much interest.

Electrical Demonstration.—Messrs. H. Rowe and Co. recently held a very successful series of demonstrations of domestic electric fittings and apparatus at their showrooms, Mill Place, Melbourne. The display was open to the public for a period of one week, and by means of extensive advertising large numbers of people were attracted. The rooms were divided into two sections, one for the display of lighting fittings, radiators and vacuum cleaners, and the other devoted to cooking apparatus, washing machines, hot water system, etc. The firm handles Jackson cooking equipment, and several types of range

and small cooking apparatus were exhibited and demonstrated in action. The Savage clothes washing machine, which has been mentioned in these columns, was also on view and created an excellent impression by its simplicity and economy. The Hecla hot water system and Hecla radiators in many designs formed an exhibit suitable to the season. A further piece of apparatus which has been imported recently is the Jackson electric copper, which is arranged for boiling a large quantity of water in a short time. In their special demonstration, Messrs. H. Rowe and Co. have not only benefitted themselves, but in bringing electrical apparatus under public notice, have performed a service to the whole industry. The firm has arranged for a series of cooking demonstrations to continue from week to week.

The Universal Electric Stove.—The steadily increasing popularity of electric cooking is engendering keen competition amongst manufacturers of electric ranges. Stoves of many types are already on the market, many of them giving



The Universal Stove.

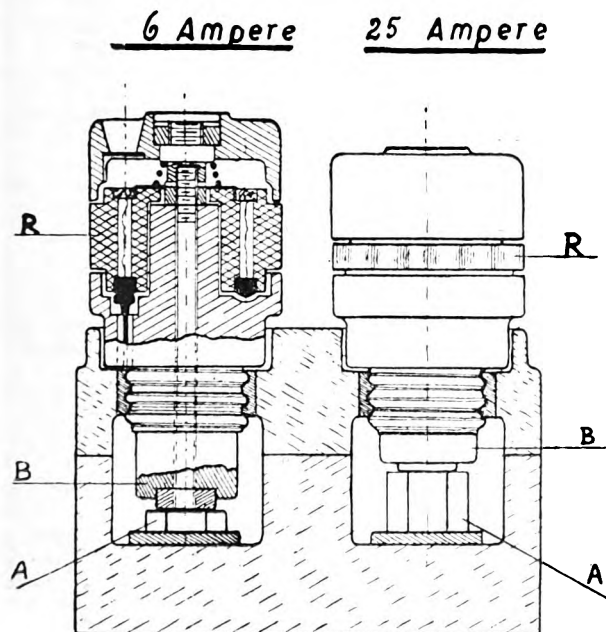
evidence of great care in the finer points of design which make for economy in operation. The Universal line is well to the fore amongst the better types and caters for a large range of requirements. The stove illustrated is one well suited to the needs of the average small family. The oven is of rectangular section, 12 in. by 12½ in. by 16½ in. wide, and is equipped with top and bottom elements. The top element is of the open type and is rated at 1,500 watts maximum. It has a large area and is very suitable for grilling and toasting. It is wound on a frame arranged for ready removal for cleaning or repair but, although accessible, it is adequately protected against damage or accidental contact in virtue of its position. The bottom element is of the totally enclosed type. It is rated at 1,000 watts and works in conjunction with a removable heat diffuser which fits into the lowest of the oven slides. The stove top is equipped in

different models with either two or three totally enclosed hot plates. The left hand plate is rated at 1,500 watts and the right hand at 1,000 watts, while the middle element in the three plate model is rated at 660 watts. All elements, both top and oven are arranged for three heats. The Universal enclosed type hot plate is constructed in a peculiar manner which renders it very efficient and at the same time readily accessible for repairs. The whole plate clips on to the stove and may be easily removed with slight leverage. The cast iron top is very simply detached from the remainder of the assembly, thus leaving the element entirely exposed. The latter consists of a spiral of nichrome wire wound in zig-zag formation around a number of small porcelain insulators attached to the bottom of the iron plate. A new element may be wound into position in a few moments and thus the labor cost in the event of a repair becoming necessary is very slight.

The switches controlling the elements are strongly constructed and quite safe to operate. All wiring is concealed and immune from possibility of damage. The elements are balanced and may be arranged either for three wire or three phase connection. The stove itself is constructed of sheet metal on a steel frame, and is well lagged. The door is of wrought iron, and it carries an indicating thermometer. The prices for the type illustrated range from £23/10/- for the stove with two hot plates and no back or shelf, to £28 for a three hot plate stove with back and shelf. Messrs. W. G. Watson and Co., of Melbourne and Sydney, are the Australian agents for the Universal line.

The Simplex Safety Fuse.—A clause in the recently issued amendments to the wiring rules of the Institution of Engineers, Australia, states that on and after Jan. 1, 1926, installation will not be permitted of any type of fuse which requires the connecting of the fuse wire to terminals mounted on the base block. Fuses of all sizes, thereafter installed, must be of the removable and safe-replacement type of an approved design. The Simplex Safety Fuse, which is handled throughout Australasia by the Gloria Light Co. of Australia, is of the latter type, and conforms in every respect with the new wiring regulations. In addition it possesses unique features which make it a particularly useful piece of apparatus. It consists of a porcelain base block carrying substantial terminals arranged for either front or back of panel wiring. One terminal is connected to a brass base block, A (see illustration), while the other makes connection with a socket of the screw type. A porcelain cover, which is fastened with one screw provides ample protection for the terminals and connections. The fuse plug consists of a porcelain body, having a central stem of brass which communicates with the brass

contact in the porcelain base, and a brass cased thread at its lower end for screwing into the screw socket carried by the base. A porcelain ring fits over the upper part of this body, being secured in place by a porcelain cap which screws on to the upper part of the central stem. A compression spring holds the ring firmly in position when the cap is on. The ring carries nine separate fuses supported between upper and lower contacts as shown in the diagram. The



The Simplex Safety Fuse

upper contacts are all soldered to a brass plate which makes contact, through the spring, with the central stem, and thus with one of the base terminals. In the lower portion of the porcelain fuse body a single contact is carried, which makes connection between one fuse and the brass screw socket, and thence to the other terminal. Thus one fuse only is in circuit at a time. When that fuse blows re-loading is a very simple matter. It is only necessary to take hold of the fuse carrier ring, lift it slightly against the compression of the spring, and turn it until the next fuse comes opposite the single contact. When all nine fuses have blown the cap may be removed and a spare fuse ring inserted with a minimum of trouble, and no danger of contact with live parts. An indicating device is provided by a mica window in the porcelain cap, through which the upper fuse contacts may be viewed. The blowing of a fuse disturbs this upper fixing and thus reveals itself. The fuses are made in sizes ranging from 6 to 25 amp., and in single and double pole. The prices range from 4/6 for the 6 amp. s.p. to 10/3 for the 25 amp. d.p.

Transformer Standards.—A new edition of Transformer Standards of the Electric Power Club has just been issued, dated January, 1925. It contains all the new standards which have been adopted since the previous edition was issued and is up-to-date in every respect. This valuable reference work is priced at 35 cents in America and is obtainable on application to the Electric Power Club, B. F. Keith Building, Cleveland, Ohio, U.S.A.

Pacific Cable.—In connection with the duplication of the Pacific Cable Board's cables, Messrs. Siemens Bros. and Co. Ltd. have received the order for the section between Fanning Island and Suva (Fiji), a length of rather more than 2,000 nautical miles. The cable will have a speed of signalling very much higher than hitherto practicable, the improvement being obtained by the introduction of continuous loading. The copper conductor will have a wrapping, underneath the insulation, of a material which is an alloy of iron, having a permeability very much higher than that of soft pure iron.

THE APPEARANCE OF THE SHOP FRONT

Unfortunately electrical retailers do not always seem to realise that appearances count for a great deal with the public. Not only is good window dressing necessary for attracting attention, but the whole shop front must be kept smart and attractive. There is very little difficulty about doing this in these days of bronze window fittings which can be kept clean quite easily. It does not matter what the surroundings of the shop are like, cleanliness is essential. If the shop has a drab and dirty appearance it conveys to the passer-by the impression that the stock also is drab and dirty. Of course it is understood that the retailer cannot always afford to redecorate or repaint at the precise moment when this work becomes necessary; but there is only sheer indolence to hinder him from scrubbing the woodwork, polishing the brass, cleaning the windows and dusting the stock.

On the other hand the attractiveness of the window fittings may be overdone to an extent that removes attention from the stock, though this is hardly likely. An artistically designed exterior to a shop is a great advantage. The doorway should be wide enough to invite entrance, yet not so wide as to limit the window space. The floor of the window should not be so low that the passer-by has to stoop to examine something on it, nor so high that he has to stretch his neck to see something at the back. It must always be remembered that the prosperous looking shop front will tend to attract prosperity to the shop owner.—(Electrical Times.)

Electrical Supply Undertakings of Australia

TASMANIA

Town or City	Supply Authority	Type of Plant	Capacity	Distribution System	No. of Consumers
Bothwell	Municipal council	Bulk supply	—	400/230 volts, 50 cycle three phase a.c.	—
Burnie	"	Suction gas	60 kw.	460/230 volts d.c.	—
Cygnnet	"	Bulk supply	—	415/240 volts, 50 cycle three phase a.c.	—
Deloraine	"	Suction gas and hydro-electric	32 kw.	220 volts d.c.	140
Devonport	Municipal council purchases from hydro-electric department	Steam	—	400/230 volts, 50 cycle three phase a.c.	—
Franklin	Municipal council			220 volts d.c.	100
Gormanston	Mt. Lyell Mining and Railway Co.	See Queenstown	—	230 volts, 50 cycle single phase a.c.	120
Hobart	Hydroelectric department	Hydroelectric	57,450 kv.a.	415/240 volts, 50 cycle three phase a.c.	—
Kingston	Kingborough municipal council	Bulk supply	—	"	180
Latrobe	Latrobe Hydroelectric Co.	Steam	355 kw.	460/230 volts d.c.	210
Launceston	City council	Hydroelectric Steam and bulk supply	3,875 kw.	415/240 volts and 190/110 volts, 50 cycle three phase a.c.	—
Longford	Municipal council	Hydroelectric	45 kw.	480/240 volts, d.c.	130
New Norfolk	Hydroelectric department	"	—	415/240 volts, 50 cycle three phase a.c.	—
Penguin	Municipal council	Bulk supply	—	220 volts, " 50 cycle single phase a.c.	—
Queenstown	Municipal council purchases from Mt. Lyell M. and R. Co.	Hydroelectric	7,200 kw.		—
Scottsdale	Municipal council	"	50 kw.	415/240 volts, 50 cycle three phase a.c.	120
Stanley	Circular Head municipal council	Crude oil	40 kv.a.	"	120
Ulverstone	Leven municipal council	Bulk supply	—	400/230 volts, 50 cycle three phase a.c.	—
Wynyard	Table Cape municipal council	Suction gas	45 kw.	460/230 volts d.c.	320
Zeehan	Hydroelectric department	Bulk supply			—

Lighting and Power

Albany, W.A.—The municipal council is raising a loan of £7,000 to finance alterations and extensions to the electric supply scheme. The present power station contains three suction gas engines driving generators with a total capacity of 105 kw. Further plant to be installed includes two crude oil engines direct coupled respectively to a 100 kw. and a 10 kw. 460 volt d.c. generator. The smaller set will be required to run unattended for eight hours for the night service. A new switchboard also is to be erected to take the place of the existing panels. The present suction gas plant is to be overhauled and put in first-class order. The reticulation system is to be changed over from 220 volt two wire to 440/220 volt three wire d.c. Provision is also being made for the erection of a line to supply Middleton Beach, three miles distant. Mr. J. R. W. Gardam, of Perth, is the consulting engineer.

Alexandra, N.Z.—The Otago Central power board has been authorised to secure a loan of £25,000 for the purpose of carrying out an extended reticulation scheme.

Auckland, N.Z.—The proposal for amalgamation of the Waitemata power board with the Auckland board has been definitely abandoned.

Barham, Vic.—The Wakool shire council has decided to proceed with the electric supply project as early as possible. It has been proposed that Koondrook should take supply from the Barham generating plant.

Berrigan, N.S.W.—Mr. M. Moore has been appointed erecting engineer to the Berrigan, Tocumwal, and Jerilderie shires in connection with the electric lighting schemes.

Berry, N.S.W.—A referendum on a proposal to instal electric light throughout the district resulted as follows: Yes, 129; No, 112.

Bothwell, Tas.—Energy from the municipal electric supply scheme was switched on on April 8. Power is purchased in bulk at 11,000 volts from the hydroelectric department, and distributed at 400/230 volts, 50 cycle three phase. It is stated that 99 per cent of the residences in the town have been connected to the supply. Street lighting is provided by 27-50 c.p. lamps. Mr. C. B. Davies, consulting engineer, has been responsible for the scheme, and the installation work has been carried out by the council's staff under his supervision.

Cairns, Qld.—The city council has instructed the consulting engineers, Christie and Reynolds, Brisbane, to proceed with plans and specifications covering extra reticulation estimated to cost £5,000.

Corowa, N.S.W.—The largest of the three suction gas engines at the municipal power house was wrecked on April 29, the combustion chamber and cylinder jacket being blown to pieces. The engineer in charge, Mr. H. Grimmond, heard a knock develop, and was in the act of shutting off the gas when the accident occurred. Some two months ago the crank shaft of this same engine broke and had to be replaced at a cost of £150. The engine is rated at about 80 h.p. and had been purchased through the electricity commission from Camperdown. It is stated that a similar mishap occurred with another engine at Corowa some twelve months ago.

The council has approved of the plans submitted by the electricity commission for conversion of the electric supply from d.c. to a.c., and has adopted the commission's recommendation that the council borrow £12,000 for the purpose of the conversion and of repaying the balance of the existing loan. It is stated that it will be necessary to strike an additional rate of 1½d. in the pound in connection with the scheme.

Diamond Creek, Vic.—The co-operative cool store is considering the matter of installing electric light and power. If this is done it will make possible a general supply for the township. The energy will probably be taken from the electricity commission.

Fairfield, N.S.W.—During the year ended Dec. 31, 1924, the municipal electricity undertaking, which operates on bulk supply from the Sydney city council, purchased 183,975 units of energy, and sold 160,578 units. The gross revenue for the period amounted to £4,022, and the working costs and capital charges totalled £3,121. There are 720 consumers, and 170 street lamps on the system. Mr. H. K. Crisp is the electrical engineer.

Gladstone, Q'ld.—The municipal council has completed extensive alterations and additions to its supply undertaking. The distribution system has been altered from 220 volt two wire to 480/240 volt three wire d.c. A 94 h.p. Ruston and Hornsby twin cylinder suction gas engine, belt coupled to a 60 kw. generator, has been installed, and a new 480/240 volt generator has been coupled to the existing 60 h.p. engine.

Hastings, N.Z.—The price of energy for cooking has been reduced from 4d. to 2d.

Hepburn, Vic.—The new plant of the Hepburn Springs Electric Supply Co. was officially put into commission on May 5.

Invercargill, N.Z.—The Southland power board has recommended that no non-consumers' rate be levied this year, and that the deficiency in the board's revenue be made up by a general rate on the unimproved value of all rateable property within the board's district, and by a separate rate over a portion of the district to be defined by special order.

Ithaca, Q'ld.—The municipal council has applied to the government for permission to raise an amount of £26,491, by the sale of debentures, to acquire the electric supply system at present under the control of the tramway trust.

Kalgoorlie, W.A.—Records of the municipal electric supply department for the four months Nov., 1924, to Feb., 1925, inclusive, show a falling off in the demand for electrical energy as compared with a similar period last year. The costs, however, have shown a more than proportional decrease, so that the cost per unit sent out, including everything except depreciation, is now 3.354d. as compared with 3.547d. The gross profit for the period was £1,453, and the nett profit £787.

Katoomba, N.S.W.—The municipal council has decided upon the following charges for electric supply:—Lighting, 9d. per unit; power, 4d.; minimum charge, 4/- per month;

meter rent 10/- per annum. The charges are to operate for six months, at the end of which period they will be further reviewed.

Kiama, N.S.W.—The public works department, which gives bulk supply to the town, has notified the council of its intention to reduce by 25 per cent the price of electric current for power, conditional on the passing on of the concession to consumers.

Koondrook, Vic.—The Kerang shire council is considering an electric supply scheme for Koondrook.

Laverton, Vic.—The electricity commission has informed the shire council that the estimated revenue does not at present justify the installation of electric supply in the district. The expected industrial development, consequent upon the proposal of the government to locate certain noxious trades and the stock yards in the vicinity would make an electric supply scheme an economic proposition.

Lorne, Vic.—The Winchelsea shire council is calling tenders for the removal of the present electric lighting plant, consisting of a 12½ h.p. Petter kerosene engine, a 230 volt d.c. generator, switchboard, etc., as larger plant is being installed.

Meredith, Vic.—The progress association is making enquiries with a view to having electric supply installed.

Northcote, Vic.—The city council is raising a loan of £16,500, £10,000 of which is to be devoted to changing over the electric supply system from single phase to three phase. Current is at present purchased in bulk from the Melbourne Electric Supply Co., but it is proposed to take supply from the state electricity commission.

North Dorrigo, N.S.W.—Mr. W. Corin, consulting engineer, Sydney, has reported to the Dorrigo shire council on the extension of the hydroelectric scheme to North Dorrigo.

Nyngan, N.S.W.—The municipal council proposes raising a loan of £5,500 for the purpose of installing an electricity supply scheme.

Orbost, Vic.—The Orbost Butter and Produce Co. is increasing its electric supply plant by the addition of a generator driven by an 80 h.p. Kynoch suction gas engine operating from a charcoal gas producer.

Palmerston North, N.Z.—The following revised scale of charges for motive power has been adopted:—4d. per unit for first 200 units per month, 3½d. for next 100 units, 3d. for all in excess.

Port Kembla, N.S.W.—The public works department has approved of the construction of the transmission line to Gerringong, Berry and Nowra. A sum of £19,500 has been made available for the work.

Roxburgh, N.Z.—The Teviot power board has recently carried a proposal to raise a loan of £23,000 for electric supply purposes.

Sandgate, Q'ld.—The electric supply from the new scheme under the control of the metropolitan electricity board was officially switched on in the evening of April 8. Energy is purchased in bulk from the City Electric Light Co., Brisbane, and distributed at 415/240 volts, 50 cycle three phase.

Shepparton, Vic.—The electricity commission is making arrangements to replace certain portions of the electric supply plant in order to provide a more efficient service than has been available of late.

Tauranga, N.Z.—The Tauranga power board has decided to institute a system of hiring single phase motors to consumers, giving the customer the option of purchase.

Temuka, N.Z.—The electric supply, which is under the control of the South Canterbury power board, has been switched on. This marks the completion of the first stage of the board's reticulation work.

Toogoolawah, Q'ld.—The Esk shire council some time ago approved of a proposal that current for lighting should be supplied to the town by Messrs. Nestle Ltd. The council is now applying for permission to raise a loan for carrying out the necessary work.

Violet Town, Vic.—Contracts have been placed for the supply of plant and equipment for the municipal electrical undertaking. Fairbanks-Morse generating sets are to be installed, comprising one 25 h.p. engine driving a 22½ kv.a. alternator, and one 15 h.p. engine driving a 10½ kv.a. alternator. The switchboard will be supplied by Messrs. Foster and Fish. Further contracts are as follow:—Supply and erection of poles and erection of reticulation, Clements and Stewart; supply of bare copper cables, British Insulated and Helsby Cables Ltd. The system is to be 400/230 volts, three phase 50 cycle. Messrs. Christie and Gardiner are the consulting engineers.

Walcha, N.S.W.—On May 2, the official "switching-on" of the municipal electric supply undertaking was performed by the mayoress. The installation, including reticulation, cost approximately £5,500, and includes two Ruston and Hornsby crude oil engines of 42 and 16 h.p. respectively, coupled to Crompton generators of 23 and 7 kw. The main switchboard is fitted with Western

Electric instruments and was designed and built by D. Armstrong, of Sydney. The supply system is 480/240 volts, three-wire, d.c., and the prices charged are: Lighting, 10d., power, 6d. per unit. J. D. Handley and Co. were the contractors for the reticulation scheme. To date 60 consumers have applied for connection and it is anticipated that these figures will increase to 100 in the next few weeks. Mr. W. P. Castle is town clerk and Mr. C. W. Wardle, electrical engineer.

Warrnambool, Vic.—Electric lighting has been installed along the harbor front and on the breakwater.

Warracknabeal, Vic.—The Warracknabeal Electric Light Co., has been formed with £20,000 nominal capital, to inaugurate an electric supply undertaking. Mr. Donald Scott, of Scott street, Warracknabeal, is secretary. Messrs. Christie and Gardiner, consulting engineers, Melbourne, have recommended a scheme estimated to cost £11,504. The system proposed is 415/240 volts, 50 cycles, three phase, a.c.

Current Prices for Electrical Supplies

The quotations in this list represent the average retail selling prices ruling in Melbourne during the month of publication. These prices are subject to bona fide traders' discounts. Special rates are obtainable in most cases for large quantities. In general Sydney prices are slightly lower.

Adaptors—

Hardwood	doz.	11/3
Parallel	each	6/6

Blocks—

3 in. round	gross	22/6
3½ in. round	gross	25/
6 in. x 3 in. rectangular	doz.	6/8
9 in. x 3 in. rectangular	doz.	8/9
6 in. x 6 in. square	doz.	12/6

Bushes—

½ in. ideal metal	gross	7/6
¾ in. ideal metal	gross	7/6

Bushes—

¾ in. ideal metal	gross	8/9
¾ in. plain wooden	doz.	1/6
¾ in. plain wooden	doz.	1/8
1 in. plain wooden	doz.	2/

Bells and Bell Material—

Bell transformers	each	12/6
1½ volt dry cells	each	3/4
Bell wire—1/029 d.c.c.	1,000 yd.	32/6
1/036 d.c.c.	1,000 yd.	42/6
1/029 d.c.c. and i.r.	1,000 yd.	50/
1/036 d.c.c. and i.r.	1,000 yd.	60/

No. 2 porous pots	each	2/1
No. 2 jars	doz.	8/9
No. 2 zincs	each	1/3
Salammoniac	lb.	1/3
2½ in. wood box bells	each	4/6
2½ in. iron box bells	each	4/6
3 in. wood (church gong)	each	18/4
Bell presses	from each	3/9

Pocket Lamp Batteries—

Batteries, pocket lamp	each	1/10
2-cell batteries	each	2/5
3-cell batteries	each	2/8

Ceiling Roses—

	English	Japan
2-plate	doz.	11/8
3-plate	doz.	15/

Connectors—

1-way, porcelain	doz.	2/6
2-way, porcelain	doz.	4/
3-way, porcelain	doz.	5/

Counterweights—

Porcelain	each	2/6
Brass	each	5/6
Shot for same	lb.	6½d.

Casing and Cover—

Best white pine	100 ft.	12/6
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Conduit—

	Plain	Screwed
½ in.	100 ft.	10/
¾ in.	100 ft.	10/10
1 in.	100 ft.	16/3
1 in.	100 ft.	27/6
1½ in.	100 ft.	45/
1½ in.	100 ft.	68/
2 in.	100 ft.	100/
2 in.	100 ft.	150/
¾ in. oval	100 ft.	12/6

Conduit Fittings—

	½ in.	¾ in.	1 in.
Grip—Tees	doz.	6/	6/3
" Elbows	doz.	4/9	5/
" Couplings	doz.	3/6	3/9
Crampets	gross	5/5	5/5
Saddles	gross	5/	5/

	½ & ¾ in.	1 in.
Screwed tees	doz.	5/5
" elbows	doz.	3/9
" couplings	doz.	2/9
" bell mouths	doz.	5/5
" " 1 in.	doz.	14/10
" " 1½ in.	doz.	19/6
" " 1½ in.	doz.	27/

Junction Boxes—

	½ in. & ¾ in.	1 in.
2-way	doz.	10/10
3-way	doz.	11/3
4-way	doz.	11/8

Fuses (Cut-outs)—

	British	Japan
5 amp, anchor type	doz.	11/3
5 amp, round chamber	doz.	17/6
8 amp, round chamber	doz.	25/
10 amp, oblong	doz.	45/
20 amp, oblong	each	—

Holders—

	English	Japan
C/G., S.C. holders doz.	13/4	9/2
1 in. and 1 in. holders doz.	13/4	9/2
Batten holders doz.	15/	11/3

Lamps—**Metal Filament, Vacuum Type**

25 to 250 volts, 20 to 60 watt each	2/
20 to 250 volts, 100 watt each	5/

Gas-filled Type

20 to 250 volts, 25 to 40 watt each	2/9
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All voltages	60 watt each	3/3
	75 watt each	3/9
	100 watt each	5/3
	150 watt each	7/
	200 watt each	9/
	300 watt each	13/
	500 watt each	17/6
	750 watt each	22/6
	1000 watt each	27/6
	1500 watt each	40/

Carbon Filament

All voltages, 5 to 32 candle power doz.	24/
All voltages, 50 candle power doz.	42/

Plugs—

5 amp two pin plugs doz.	32/6
5 amp two pin tops doz.	15/

Switches—

	English
5 amp s.p. pol. brass doz.	18/9
5 " s.p. ox. copper doz.	21/6
5 " 2-way pol. brass doz.	32/6
5 " 2-way ox. copper doz.	38/6
10 amp. s.p. pol. brass doz.	40/
5 " d.p. pol. brass doz.	42/6
10 " d.p. pol. brass doz.	90/
5 " s.p. ceiling switches each	5/6

Switches—

	English
5 " 2-way ceiling switches each	7/6
1 " ceiling switch and rosette each	5/
3 " American tumbler doz.	25/
3 " s.p. indicating rotary doz.	27/6
3 " s.p. non-indicating rotary doz.	23/5
3 " 2-way rotary doz.	56/3
5 " d.p. indicating rotary doz.	62/6
10 " d.p. indicating rotary doz.	78/
20 " d.p. indicating rotary doz.	150/

Switchboards—

	English	Japan
Single circuit marble 5 amp each	11/3	9/2
Single circuit marble 10 amp each	18/9	16/3
Two circuit marble 5 amp each	20/	16/3
Two circuit marble 10 amp each	25/	22/

Switchboard Frames—

6 in. x 6 in. local make doz.	9/6
6 in. x 8 in. local make each	1/
8 in. x 8 in. local make each	1/3
8 in. x 10 in. local make each	1/6
10 in. x 10 in. local make each	1/8

Tape—

Black adhesive lb.	2/9
Pure rubber lb.	10/

Wire and Cables—

	Per 1,000 yd.
1/.044, 600 meg.	£5 12 6
1/.064, 600 meg.	£8 12 6
3/.036, 600 meg.	£9 15 0
7/.036, 600 meg.	£17 0 0
7/.044, 600 meg.	£21 10 0
7/.064, 600 meg.	£36 10 0

Flexibles—

	Per 100 yd.
23/36 cotton	£2 2 6
40/36 cotton	£2 12 6
70/36 cotton	£3 10 0
110/36 cotton	£4 5 0

Electrical Contracts

Full information regarding contracts invited and accepted is published every week in "Tenders," a registered newspaper issued from the office of "The Electrical Engineer." Subscription, 20/- per annum.

COMMONWEALTH

Dept. of Works and Railways.—Installation of electric light and power, City South Telephone Exchange, Sydney—Burgin Electric Co. Ltd.

Installation electric light and power, South Melbourne telephone exchange and Canterbury Exchange, Berkery-Picken Pty. Ltd. Control gear Maribyrnong, Allied Engineering Ltd. Motors and shares, Noyes Bros. (Melb.) Pty. Ltd. Generators, Siemens Bros. and Co.

N.S.W. Public Works Dept.—X-ray apparatus St. George's Hospital—Watson and Sons, and Australalectric Ltd.

P.M.G.'s. Dept., General.—21,000 stoneware insulators, Firebrick Insulator and Pottery Co. Pty. Ltd.; 125 tons of bronze wire, 15 tons of cadmium copper wire, 32½ tons of bronze wire—Thos. Bolton and Sons, England; 125 tons of bronze wire, 15 tons of cadmium copper wire, 32½ tons of bronze wire—F. Smith and Co.

P.M.G.'s. Dept., Victoria.—Telephone protectors, indicators, induction coils, cord weights and sleeves, switchboard keys, telephone jacks—Ericsson Tel. Mfg. Co.; Siemens Bros. and Co. Ltd.—Protectors, sub-station; L. P. R. Bean and Co. Ltd.—Protectors, sub-station; British General Electric Co.—Condensers, reactances and cord weights, telephone jacks; Western Electric Co. Ltd.—Condensers, indicators, registers, keys, switchboards, react-

ances, etc., cords; British General Electric Co.—Indicators; The New Antwerp Telephone Co., through High Commissioner, London—Indicators; Lawrence and Hanson Elec. Co. Ltd.—Voltmeter and milliammeter, cord; keys, telephone—Telephone Mfg. Co.; jacks, telephone—Western Electric Co. (Aust.) Ltd.; jacks, telephone—British General Elec. Co. Ltd.; jacks, telephone—R. O. Whitford; insulators, glass—Aust. Glass Manuf. Co. Ltd.; insulators, porcelain—Drayton Bros.

P.M.G.'s. Dept., N.S.W.—20,000 porcelain insulators—R. Fowler Ltd.

P.M.G.'s. Dept., Sth. Aust.—Material for extension of Central Exchange multiple—British General Electric Coy.; material for extension of Central Exchange multiple—Western Electric Coy.

STATES

Victorian Railways.—Egg strain insulators—Allied Engineering Ltd.; ebomite accumulator accessories—Barnett Glass Rubber Co.; three phase alternating current induction motors starting apparatus, etc.—Crompton and Co. Ltd., and Noyes Bros. Pty. Ltd.; hard drawn copper strip—British Insulated and Helsby Cables Ltd.; catenary supporting insulators—Australian Porcelain Co. Pty. Ltd.; Kelvinator electric automatic refrigerator ice chest—Due and Le Quesne Pty. Ltd.

State Electricity Commission of Vic.—Lead covered and armoured cable—British Insulated and Helsby Cables Ltd.; transformers and spares—Thomas Bros. Pty. Ltd. (Part), 35 ton elect. operated travelling crane—Noyes Bros. (Melb.) Pty. Ltd.; valve operating gear—Orton and Burns; switchgear and accessories—Metropolitan Vickers Elect. Co. Ltd.

South Aust. Supply and Tender Board.—rubber-covered copper wire—General Railway Signal Co. Pty. Ltd.

GENERAL

Brisbane Tramway Trust.—Eight miles trolley wire—Wm. Adams and Co. Ltd.; special wire—R. W. Cameron and Co.

Melbourne City Council.—300 ornamental street lanterns—Australian General Electric Co. Ltd.; motor and starter—Noyes Bros. (Melb.) Pty. Ltd.; suspension contactors—Johnston and Ashton; tramway pole lighting units—S. W. Newman; insulating tape—W. McLean and Co.

Melbourne and Metropolitan Tramway Board.—Overhead electric travelling crane—Gibson, Battle Pty. Ltd.; low tension feeder cable—British Insulated and Helsby Cables Ltd.

Mt. Lyell Chemical Works.—25 acid proof motors—Noyes Bros. (Melb.) Pty. Ltd.

Sydney City Council.—Feed protective apparatus, 10,000 volt system, relays, current transformers, trip coils and escutcheon plates, primary batteries and battery boxes—Metropolitan Vickers Electrical Co. Ltd.; potential transformers, escutcheon plates and trip coils—British Thomson Houston Co.; escutcheon plates and trip coils—Ferguson, Pailin Ltd.; distribution transformers, Electrical Plant Manufacturers Ltd.; H.T. underground cables—W. T. Henley's Telegraph Works Co. Ltd.; maximum demand indicators—W. G. Watson and Co.; maximum demand indicators—Australian Electric Co. Ltd.; meter parts, wheels, worms and pinions—Electricity Meter Mfg. Co. Ltd., and Noyes Bros.; meter register dial plates—Bryden Brown and Co.; pitch or refined bitumen—Vacuum Oil Co. Pty. Ltd.

Violet Town Shire, Vic.—Two semi-diesel engines, alternators—Fairbanks Morse Co. (Aust.) Ltd.; switchboard—Foster and Fish Pty. Ltd.

NEW ZEALAND

Dunedin City Council.—Six 100 kw. transformers—Metropolitan Vickers Electrical Co. Ltd.

Lyttelton Harbor Board.—Four 3 ton electric cranes—Babcock and Wilcox.

New Zealand Public Works.—Mangahao, section 147—110 kw. switchgear—Metropolitan Vickers Ltd., and Reyrolle and Co. Ltd.; Coleridge, section 181—induction regulators—National Electric Co. (G.E. Co.); Mangahao 19/16 copper cable—P. R. Baillie (Australian); installation of electric light, Palmerston North—Mansel and Barr (Ltd.).

Taumarunui Borough Council.—One 62 k.v.a. and one 30.15 k.v.a. condenser—A. D. Riley and Co. Ltd.

Tauranga Electric Power Board.—1½ h.p. motors—Bycroft Ltd.; meters—A. D. Riley and Co.; fuses, 2 and 3 h.p., thermal cut-outs—National Electrical and Engineering Co.

TENDERS OPEN

COMMONWEALTH

Dept. of Works and Railways.—May 18—Motors for R.A.N. College, Jervis Bay.

P.M.G.'s. Dept., General.—May 19—Telegraph paper tape, iron work. May 26—Metal jointing sleeves. June 2—Telephonists telephones. June 16—Transformers. Aug. 11—Plugs and sleeves.

P.M.G.'s. Dept., Victoria.—June 16—Transformers, counter e.m.f. cell batteries, Randwick, Waverley, Gordon and Canberra exchanges. June 11—Motor generator sets. Nov. 6—Automatic common battery telephone equipment, Canberra exchange.

P.M.G.'s. Dept., N.S.W.—June 4—Accumulator and machinery.

STATES

N.S.W. Railways and Tramways.—July 8—Supply and erection of two coal elevators for White Bay power house. Aug. 5—Ash conveyors for White Bay power house.

N.S.W. Public Works Dept.—June 29—Steel towers for transmission lines, Barren Jack. Sept. 14—Electrical equipment for Cook's River bridge.

State Electricity Commission of Vic.—May 18—Busbar supporting insulators, 6,600 and 22,000 volt; V.I.R. control gear. May 25—Structural steel building for terminal station, galv. steel terminal structures. June 15—Bare hard drawn copper cable. July 6—22,000 volt current limiting reactors. Aug. 3—Switchgear and accessory equipment. Sept. 14—3,000 kv.a. transformers and spares.

Tasmanian Hydro Electric Dept.—June 30—Material for 88,000 volt transmission line.

Victorian Railways.—May 20—Electric storage battery. May 27—Copper rod, high speed turbine lathe and electrical equipment. June 1—Tachograph and charts. June 3—2,200 volt cable; electrically operated tuning fork; telephone cables. June 10—Overhead electrical equipment. June 17—Two phase a.c. induction motors, starting apparatus and accessories. June 24—Copper plates. July 1—Electric cables (spares). July 8—Double recording instrument. July 39—Point detection transformers.

GENERAL

Albany Municipality, West. Aust.—May 25—Crude oil engines, generators, switchboards, etc.

Brisbane Tramway Trust.—May 27—Tramway sub-station equipment. May 21—Motor buses.

Melbourne City Council.—June 1—Four three phase transformers, electricity meters, paper insulated lead cables, ornamental standards. June 15—Condenser and boiler tubes. June 15—High and low tension three phase sub-station switchgear.

Sydney City Council.—June 1—Insulating and friction tapes.

NEW ZEALAND

Auckland Electric Power Board.—May 25—Rotary converters; transformers; rotary balancer; electric crane.

Franklin Electric Power Board.—June 30—1,000 volt insulators, bare copper wire, triple braided and insulated wire.

Grey Electric Power Board.—May 26—Tape, switches, fuses and notices. Notice is given for the supply of 110 volt underground cable and series.

Invercargill Borough Council.—June 2—Reaction on Aug. 17—Single phase transformers, 110 kv. as on the

Public Works Dept.—June 23—Portable 2,300/500 volt generators.





Editorial





THE POLE PROBLEM

Electric supply authorities in all parts of the world are finding increasing difficulty in obtaining supplies of satisfactory wooden poles at moderate cost. The steady expansion of reticulation schemes, not only in the towns, but in country districts, is increasing the demand for poles, while the general cutting out of forests for timber supplies of all descriptions is decreasing the supply. Many of the timbers which give the longest life as poles are already relatively rare and, in consequence, the cost is becoming almost prohibitive. This applies mostly to the larger poles which are required for high tension transmission lines, though the smaller sections also are getting dearer. Therefore, while great strides are being made with country district supply schemes it is necessary to face the fact that the increasing cost of poles is drawing the economical limit of reticulation into a smaller and smaller radius.

That this fact is already realised by supply engineers is evident from the steps that are being taken in endeavors to provide for plentiful supplies of poles at reasonable cost. New Zealand is perhaps one of the most forward countries in the matter of rural reticulation. The power boards are extending their lines in districts of very low loading density. This is bringing about such a demand for poles that local supplies have proved insufficient and many of the boards have had to import their poles, using both Australian hardwoods and American oregon. Such procedure is naturally expensive. The normal tendency in view of the shortage of timber is to seek some other form of line support. Lattice steel and reinforced concrete poles have both been tried out, but are too expensive for any except the densely loaded lines, and therefore do not assist in solving the problem.

A partial solution appears to be offered in action such as has been taken by several of the New Zealand power boards in adopting a policy of afforestation. With commendable foresight these authorities are planting certain areas with types of trees suitable for power pole purposes. The Paks Peninsula board has already planted a considerable area of land which has been reserved to it for the purpose by altruistic action on the Akaroa reserve. A start has been made with the planting of *pinus insignis* and other species of *Pinus*. An additional *Pinus* and larch. Arrangements for planting are being made for certain Australian

hardwoods: jarrah, ironbark and blue gum. These are examples of action that is likely to become general in the Dominion.

But even the very best of wooden poles are not altogether satisfactory. They require preservative treatment in order to obtain anything like a reasonable length of life; they can seldom be absolutely depended upon; and, particularly in countries where termites have their habitat, the cost of keeping a wooden pole line in order is quite a serious burden. Indeed, where large amounts of power are being transmitted over long distances and absolute reliability is required, wood gives place to steel in spite of the expense. As a matter of fact wooden poles are used for the support of overhead reticulation rather because there has been no generally effective and economical substitute for them, than for any particular virtue of their own. Engineers would welcome the development of a line support that would give absolute reliability, save the trouble of frequent pole replacements, and yet be as reasonable in cost as wooden poles have been in the past.

Considerable interest, therefore, should be aroused by a recent development which shows promise of providing such a line support. Claims in respect of reliability, reasonable first cost, and ease of handling made on behalf of the Stobie steel-concrete pole, an Australian patent, appear to be substantiated by experience. Stobie poles have already been given a thorough try-out in service, and although their length of life is not accurately known, there is strong cause for believing that they provide a very effective solution of the pole problem. An article on another page describes this new pole and its method of construction. Figures quoted show that it has very strong advantages over the wooden pole not only for moderately high tension transmission, but for local distribution lines.

BROADCASTING IN NEW ZEALAND

The people of New Zealand have been unfortunate in their experience of broadcasting. Some 18 months ago the government announced a project for providing the Dominion with "the best broadcasting service in the world," but so far very little definite progress has been made towards this ideal. As a matter of fact there would have been no development of broadcasting services up till now had it not been for the enterprise of certain radio traders who recognised that they would sell no apparatus were there nothing for people to listen to. An attempt was made by private interests to put a stop to even

such services as were being given, on the grounds of infringement of patents, but the government intervened on behalf of the broadcasters and allowed them to carry on under its protection. Apart from this, however, the government has rather hindered than helped progress. It has demanded a definite minimum standard of broadcasting service, but the subsidy paid to the broadcasters out of license fees has not been adequate for the maintenance of that service. The broadcasters, however, have carried on in face of this, for there was a general understanding that the conditions were only temporary. The scheme which the government had under consideration provided for the licensing of four main broadcasting stations operated by one privately financed company. A syndicate was formed some 14 months ago in order to make arrangements for floating the company and to arrive at an agreement with the government. It was not till March, 1925, however, that regulations were gazetted, and even then they were of such a nature that no company could undertake services with a prospect of success. After some trouble the government was prevailed on to amend the regulations, but, although the syndicate is ready to form the company and has submitted all its requirements to the government, the agreement is still awaiting finalisation.

In the meantime the license fees for listeners-in have been raised from 5/- to 30/- in order to pay for the improved service. The delay on the part of the government in providing that service is quite unjustifiable and is likely to react seriously on the radio business. It seems remarkable that it should take 18 months to draw up satisfactory regulations and come to an agreement with one company. In justice to the people who are paying for a service that they are not getting, and to the present broadcasters who are doing their best to keep the radio business alive, the government should make every endeavor to finalise its arrangements as soon as possible.

Notes and Personals

Mr. R. Cecil Creasey has joined the staff of the Australian Westinghouse Electric Co. Ltd., Sydney.

Mr. E. T. Fisk, managing director, Amalgamated Wireless Ltd., Sydney, left for Vancouver by the Niagara on June 4.

The electric supply committee of the Melbourne city council has decided to broaden the regulations governing the use of electric signs in the city. Under present conditions the use of signs is severely restricted, but it is proposed to bring the regulations into line with those of other great cities.

The annual conference of the Electric Power Boards' Association of New Zealand is to be held during the first week in August.

Mr. James Paton, of the Ericsson Telephone Mfg. Co., Sydney, who has been absent abroad, returned to Australia on May 14 by the Orsova.

Mr. S. J. Bellamy, formerly superintendent of the Sydney municipal power station, has been appointed safety officer in the electricity supply department.

Mr. L. Ferris, engineer in charge of the Cowra electric supply plant, has been appointed electrical engineer to the town of Albury, N.S.W. There were 63 applicants for the position.

By a majority vote the Armidale city council, N.S.W., has rescinded the motion agreeing to participate in the northern county council's projected hydroelectric scheme at Jackadgery.

Mr. Walter Gratwicke, technical representative and engineer of the British Aluminium Co., is visiting Australia. He has spent some time in New South Wales and was in Victoria early this month.

Mr. F. G. Burton, of the Peel-Conner telephone works, recently arrived in Australia to take charge of the telephone business of the British General Electric Co. Mr. Burton's headquarters will be in Sydney.

Mr. A. Den Hertog, a member of the staff of Philips Electric Lamp Works, Holland, is at present in Australia. During his sojourn he intends visiting the principal capital cities.

Mr. F. J. Wilson, who was recently appointed assistant engineer to the Thames Valley power board, has accepted an appointment as engineer for the Waitemata power board construction scheme on behalf of Messrs. Gauvain and McLeod, consulting engineers.

The Rockhampton, Queensland, city council has been convicted of employing uncertificated line-men, this being a breach of the electrical workers' act. The council stated that the men in question had been working on the line since 1923; although every effort had been made to get certificated men, it had not been possible to do so. A nominal fine of 1/- each, with 3/6 costs, was inflicted.

The Adelaide Electric Supply Co. Ltd., appreciating the value of publicity, has made arrangements with one of the local newspapers for featuring its activities from time to time. A half-page illustrated article describing the Osborne power plant has been published as a first step. The method adopted for bringing the advantages of electricity under public notice is attractive and should have a good reaction on the electrical trade generally as well as on the company's business.

Mr. H. A. Curtis has been appointed chief engineer and general manager of the hydro-electric department of Tasmania. He was born at Lyttelton, New Zealand, and received his technical education at Canterbury College, University of New Zealand. After spending some time in the government service, he went to England and America. Returning in 1912, after an absence of 10 years, he joined the Lyttelton harbor board and afterwards was on the staff of the Christchurch city council. His next appointment was with the public works department



Mr. H. A. Curtis

in connection with the Lake Coleridge hydro-electric development. In 1915 he was engaged by the hydroelectric department of Tasmania. He superintended the construction of the Waddamana power station and, when the plant was put into operation, became power station superintendent. Later he was appointed engineer for electrical construction, engineer for electrical designs, and assistant chief engineer. Upon the resignation of Mr. J. H. Butters, in November, 1924, Mr. Curtis was appointed acting chief engineer and general manager of the department.

The Victorian electricity commission is considering plans for providing further generating plant to deal with the increasing demand. Preparations are being made for developing hydro-electric power from the Goulburn and its tributaries in the Sugarloaf district. This scheme involves laying down seven small hydro stations. It is estimated that by 1928 the demand will be such that still further power will be required. The commission is considering three alternatives: Developing the Kiewa hydroelectric scheme in north-eastern Victoria, extending the Yallourn scheme, and extending the Newport power house.

ELECTRICAL WORKERS' BOARD, Q'LD

Meetings of the board were held on April 21, and May 5 and 12. Further cases of employers and employees committing breaches of the electrical workers' act in regard to the performance of electrical work without the appropriate certificate, have been referred to the board, and arrangements have been made for prosecution of the offenders. Certificates have been granted without examination to four electrical fitters, two electrical mechanics, and one linesman.

It has been resolved:—

"That any applicant for examination who can satisfy the board that he has served an approved apprenticeship to the electrical industry, and whose application for examination has been accepted, after a statement from the apprenticeship committee has been received to the effect that such apprentice (if within its jurisdiction) has during his apprenticeship conformed to the regulations for apprenticeship under the industrial arbitration act, is entitled to sit for examination in all grades, viz.:—electrical fitter, electrical mechanic, electrical linesman and electrical joiner." It has been decided that the chairman interview the crown law department to obtain a legal opinion as to the eligibility of apprentices under the jurisdiction of the apprenticeship committees, who have not conformed to the apprenticeship regulations to sit for the board's certificate of competency by right of their five years' service only.

A list of persons holding certificates under the electrical workers' act has now been made out in book form and may be purchased at the cost of 1/- per copy from the secretary, electrical workers' board, Brisbane.

H.T. SYSTEMS CONFERENCE

The international conference on large electric systems, which was instituted in 1921, on the initiative of the Union des Syndicats de l'Electricite, will hold its third session from June 16 to 25 next in Paris. Its object is to study all questions relating to the production, transmission, and distribution of electricity as far as this concerns large stations and high tension systems. The work of the conference is divided into three sections: (1) Power production, dealing with the construction of big central stations and plant, etc.; (2) lines, dealing with the design and construction of transmission towers, etc.; (3) the working of systems, such as the operation of central stations, safety precautions, inspection, etc. Among the questions to receive special attention at the 1925 session are wireless telephony between central stations, disturbing influence of h.t. lines, earthing of

the neutral, specifications for the supply of oil for transformers and circuit breakers, standardisation of voltages, protection of towers against rust, improvement of power factor, etc. Amongst the delegates from Australia are Messrs. F. W. Wheadon, representing the South Australian section of the Institute of Electrical Engineers, and Mr. A. U. Alcock, representing the Victorian and Tasmanian divisions of the same body and also the Institution of Engineers, Australia.

THE CRUX OF THE BUS SITUATION

Peter Witt, the well-known street railway consultant, speaking recently before the American Electric Railway Association, summed up the present position of the bus and tramway competition very accurately. He said:—

You can't make transportation too good. The better you make it the more car riders you will see, and the worse you make it the fewer car rides you will sell. Now, you have got to understand that you are merchants, that you are selling something that people must have, and that people are eager to buy if you will merely deliver the stuff that they want.

You are disturbed about motor buses. I don't know what the bus can do, and neither do you. It is something new, and there isn't anything yet by which we can gauge it. All that we can say about it is that the bus is an economic factor, and that if you can transport people on rubber tyres for less than you can move them on steel wheels on steel rails, the bus will supplant the street car, and nothing can prevent it.

However, I don't think that time ever will come. I know that there isn't anything in this world that is so frictionless as a street car, a steel wheel on a steel rail. I know that there are car bodies in this country that have been on wheels for thirty-five years. I know that no bus body will remain on wheels for thirty-five years, even if you carry three mechanics on every trip. I know that there are motors operating on trucks and under street cars in this country that have been obsolete for twenty years, but they are still turning around. And I know that there isn't an internal combustion engine made, or that ever will be made, that will run thirty-five years!

I know that I can take a pinch-bar and move a gondola with 80,000 lb. of coal; that tells me that there isn't anything as cheap as steel to steel. So I don't subscribe to the theory that seems now to be running rampant among this fraternity, that the day of the street car has passed and the day of the automobile is here, because it is not. The automobile or the bus can be used, of course. There is a place for it as well as for the street car, but it will never supplant the street car in the cities of this

country, and it shouldn't, and it won't, unless it can do it cheaper—and only time will be able to demonstrate that to us.

ELECTRICITY SUPPLY ENGINEERS' ASSOCIATION, N.S.W.

The first annual meeting of the Electricity Supply Engineers' Association of N.S.W. was held at Sydney on April 15 and 16. The engineers-in-charge of supply undertakings at the following centres were present:—Bathurst, Bankstown, Blackheath, Bowral and Mittagong, Bulli, Fairfield, Glen Innes, Gosford, Hornsby shire, Lithgow, Manly, Mossvale, Murwillumbah, Murrumbidgee irrigation area, Orange, Parkes, Parramatta, Penrith, Blacktown, Prospect and Sherwood, West Maitland, Wyalong, Woollongong and Warringah shire.

The principal matters dealt with were standardisation of service rules and methods and the development of domestic cooking and water heating as a means of providing day load where industrial load cannot be obtained. Opportunity was taken of the presence in Sydney of Mr. G. H. Lofts of the hydroelectric dept., Hobart, who kindly gave an instructive address on "The Use of Electricity in the Home," and the development of domestic heating in Hobart. The officers elected for the ensuing year were: President, Mr. A. M. Conway (Orange), vice-presidents, A. J. Bradshaw (Manly), R. H. Dunstan (Prospect and Sherwood), hon. secretary, W. R. Kemp (Warringah); hon. treasurer, F. Newman (Hornsby). The secretary, Mr. W. R. Kemp, Warringah shire council, Brookvale, via Manly, N.S.W., would welcome advice from kindred bodies in the other states with the object of an interchange of ideas.

THE WAIKAREMOANA POWER DEVELOPMENT

Reference was made last month to the negotiations between the New Zealand government and the Poverty Bay power board regarding power supplies. It was stated that the board was not favorable to the proposals put forward by the government for bulk supply from the projected development at Lake Waikaremoana, as there appeared to be every possibility that the board could generate its own power in a hydroelectric station to be laid down at Te Reinga falls at cheaper rates than those offered by the government. The latter body, however, has now put forward a proposition to the board which puts the bulk supply in a more favorable light. The board has therefore formally accepted the government's terms, which means that the Te Reinga scheme will be dropped. The government will probably take immediate steps to get the Waikaremoana scheme under way.

Steel Concrete Poles for Transmission Lines

The use of wooden poles for that class of electrical transmission which lies between the extra high tension and the low tension local distribution, although general practice, is attended with certain disadvantages. Wooden poles are not always as reliable as might be desired and, even when the very best timber is used, their life is limited. In addition to ordinary ageing and decay they are subject to the attacks of fungi and termites. Thus the cost of replacements in order to keep a line in first-class order is liable to be rather high. Further than this the depletion of forest reserves and the conse-

once in place there is practically no maintenance cost. The problem, however, appears to have been solved by the introduction of the entirely new type of pole which is being largely used by the Adelaide Electric Supply Co. for country line extensions.

The Stobie steel-concrete pole is the invention of Mr. J. C. Stobie, a technical officer on the staff of the Adelaide Electric Supply Co. It consists essentially of two light rolled steel joists bolted together but spaced so that at one extremity the ends are touching and at the other they are about 15 in. apart. The space between

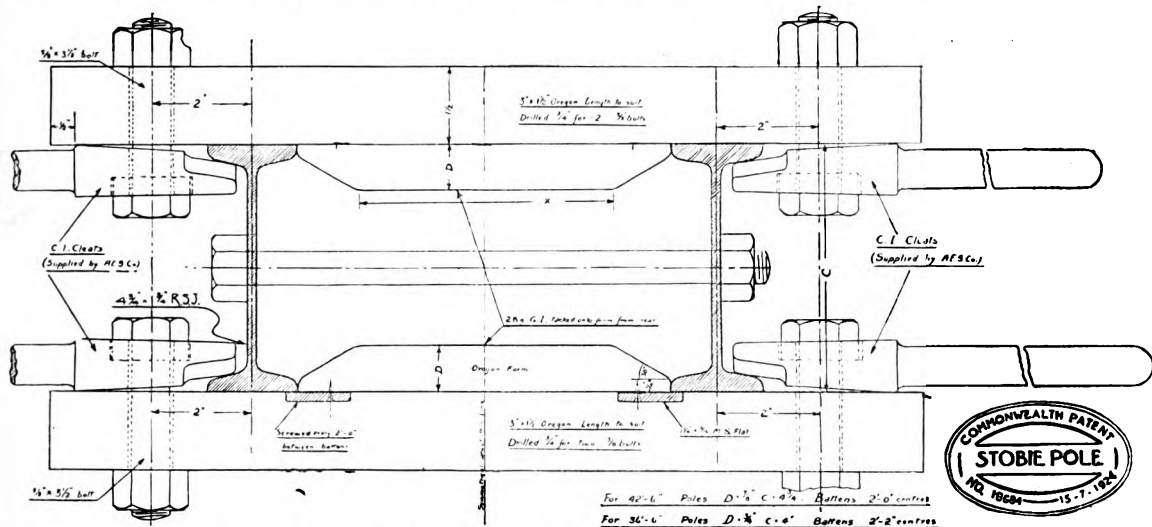


Fig. 1. Cross Section showing arrangement of Joists, Forms and Braces for making Stobie Pole

quent increase in the price of timber is making both first cost and maintenance quite a serious proposition. This applies, of course, to all wooden pole construction, but more particularly to medium tension transmission work because the poles required are of larger size, and therefore suitable timber is scarcer than for low tension work. For these reasons engineers have been coming to realise that some type of transmission line support is needed which will span the gap between the steel tower and the small wooden pole. Several fairly successful suggestions have been put forward. Steel poles, such as the Bates type, and reinforced concrete poles are coming into use in America but, although they greatly exceed in life and reliability any wooden pole, they have certain disadvantages. Steel poles are expensive, and although the Bates construction gives reasonable costs in the United States it is out of the question to import these poles to Australia. A reinforced concrete pole is also costly and is very heavy, in proportion to its strength, which makes cartage and erection an expensive proposition; although when

the joists is filled with cement concrete. This construction gives a pole which compares favorably with a wooden pole of equivalent strength, both as regards weight and cost. The method of constructing the pole will be understood from a reference to Fig. 1. The bolts, $\frac{1}{2}$ in. in diameter, are passed through holes drilled or punched in the webs of the joists, the bolt centres varying from 21 in. at the top to 45 in. at the ground line. The forms are of wood covered with galvanised iron, made up in 10 ft. lengths. These are clamped to the flanges of the joists by means of the cleats shown. Before filling with concrete the joists are laid out on greased steel slides at right angles to their length. The bolts are placed in position and lightly tightened and the lower side forms clamped on. The forms act as spacers and in conjunction with the bolts tend to keep the joists in position. The concrete, consisting of a 1: 2: 4 mix, is poured into the trough thus formed, and worked around the bolts. The top forms are then put on, tamped down and clamped into position. In the top few feet of the pole, where

the joists are close together, the forms do not recess the concrete, but allow it to run flush with the joist flanges. After the concrete has taken its first set the through bolts are tightened up.

The bolts used for attaching the crossarms, braces, footsteps, etc., are set while pouring. Their positions can be accurately fixed by template. The concrete at the upper end of the pole will readily support all the loads likely to be put upon it. After the pole has been cast and the bolts tightened up, the forms may be removed when 24 hours have elapsed, and the pole run sideways along the slides to the stacking

webs of the joists are either vertical or horizontal. A pole has been carted 20 miles without any trouble or sign of cracks. Unloading is done with the help of skids, two men being quite sufficient to steady the poles down on to the ground.

The poles are erected complete with crossarms, braces, insulators, etc., with the help of a motor-propelled pole erector, which is the company's standard practice with wooden poles. The pole is lifted by a steel rope hitched just above the centre of gravity, and brought into position with the centre line of the two joists at right angles to the length of the line. This method of plac-

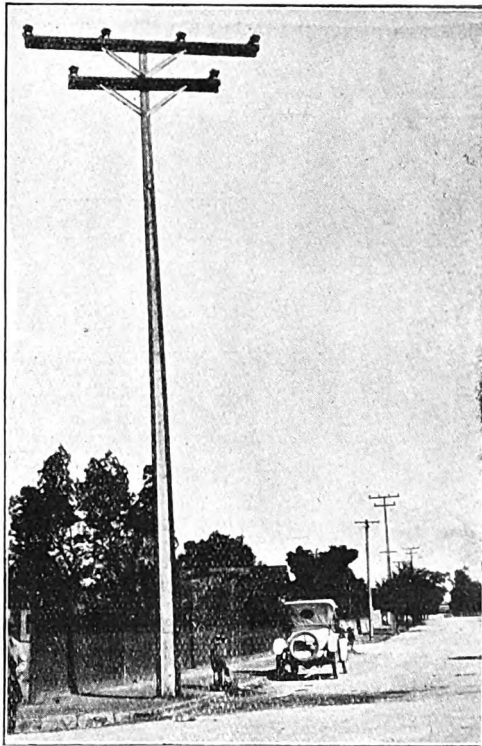


Fig. 2. Unbraced Stobie Pole at Corner

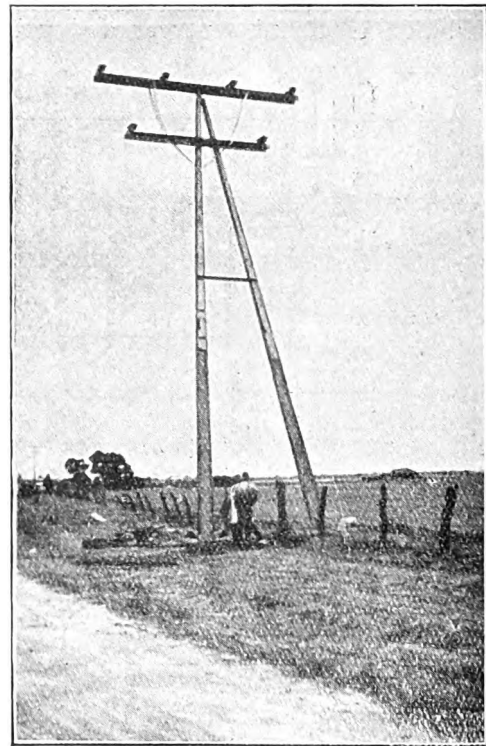


Fig. 3. Angle Bracing with Stobie Poles

and seasoning space, where the steel is painted with bitumastic paint, and where the pole should remain for at least 14 days. In order to save space on the seasoning racks and to guard against damage in cartage, the crossarm bolts are removed when the concrete has set, fresh bolts being inserted on the site of erection.

The poles are loaded on to the transporting jinker with the help of skids, sliding the pole sideways up on to the carriage by pulling with a double advantage from two points fixed to the pole and passing over the jinker. By this means and with the help of a horse to do the pulling, 12 poles can be raised on to the vehicle in about 40 minutes. No trouble has been experienced in carting the poles over rough roads to their destination. They may be carried so that the

ing the pole puts the greater strength at right angles to the line. This is required to take the stresses due to wind, both on the wires and on the pole itself and crossarms. The bearing face of the steel against the earth in this direction should be increased either with the help of a concrete footing, or with stones and earth binding well rammed at the butt. The latter method has been successfully employed for the lines at present in use, only corner poles being concreted into position.

As far as can be judged at present the only possible source of weakness in the Stobie poles is in corrosion of the joists. This is being guarded against by painting with bituminous paint, particular care being taken to seal the joint between the concrete and the steel. The

most vulnerable part, the section from one foot above to one foot below the ground surface is painted with bitumastic enamel applied hot when the pole is erected. The paint and enamel are well-known to be durable with good anti-corrosion properties, and it is expected that one application will be sufficient for many years' service. Thus there appears no reason why the poles should not have an extremely long life.

The Adelaide Electric Supply Co. Ltd., is now using Stobie poles for its high tension transmission lines supplying several country towns. Poles 42 ft. in length are used for the 33,000-volt double-circuit line running north from Gawler. On the branch single-circuit lines poles 32 ft. in

wooden poles are used. Table 1 compares the estimated costs of Stobie poles with the costs of wooden poles of various sizes. The Stobie poles have been designed to take the transverse loading shown in column 2, but tests indicate that they will safely carry much greater strains than the wooden poles which are now considered their equivalent.

The company has recently tested a Stobie pole to destruction in order to ascertain its behavior under extreme conditions and to find out if there was any weak point in the design. A 36-ft. 6-in. pole was erected with the base fastened so that it could not move in the ground, and subjected to a direct pull at the top in the direction in

Table 1
Estimated Costs of Stobie Poles Compared with Wooden Poles

Length of Pole	Approx. transverse load 1 ft. from top of pole. lbs.	Steel Weight lbs.	Concrete cubic feet	Weight of concrete and steel poles lbs.	Cost of concrete and steel poles	Cost of erection of poles	Weight of wooden poles green lbs.	Initial cost of wooden poles	Labor cost of replacing wooden poles
29 ft. 0 in.	500	290	3.70	825	£3/15/-	£1/5/-	820	£2/5/-	£2/10/-
36 ft. 6 in.	500	365	4.52	1066	£4/10/-	£1/10/-	1680	£4	£3
42 ft. 6 in.	500	553	10.00	2014	£7/6/-	£2	2120	£4/15/-	£3/10/-
47 ft. 6 in.	1575	1140	14.40	3212	£12/10/-	£2/15/-	3040	£8/5/-	£4

length are used. Fig. 2 shows a 48-ft. extra stout pole at an angle where bracing cannot be used. Fig. 3 shows the method of bracing a 42-ft. double-circuit angle pole in open country. Wooden crossarms and pin type insulators are used on all lines. To provide against undue strain in the direction of the line in the event of the conductors breaking, certain poles at intervals are equipped with guy wires. Strain insulators are not used along the lines, a double crossarm construction with two pin insulators being considered sufficient at tension points. The average span in open country is about 600 ft.

The method adopted in constructing a line is to establish a depot for pole manufacture at a place convenient for transport by rail and road. The raw materials—joists, cement, sand, aggregate, etc.—are railed to the site. A small portable concrete mixer is used and the pole making done by unskilled labor under adequate supervision. From the depot the poles are carted by road to the site of erection. Thus it will be seen that, by manufacturing in the district where the poles are to be used, cartage expenses are considerably less than would be the case for wooden poles. The first cost of the Stobie pole is on the average about 50 per cent higher than that of a wooden pole for similar service. This, however, is offset by the low maintenance costs of the steel-concrete pole, and by the fact that fewer poles per mile are needed than when

which the greatest strain would occur were the pole in use in a transmission line. The strain was applied by means of a hand winch through blocks and tackle supported by a wooden pole of extra heavy section, and was directly measured by means of a dynamometer balance. The deflection of the pole top was measured by means of a theodolite. The actual height of the pole above the ground level was about 31 ft. With application of the rated load for which the pole was designed, viz., 500 lb., the deflection at the top was about 4 in. When the load was released the pole returned to the vertical. A load of 900 lb. was next applied. This resulted in a deflection of 14 in., but when the load was released the pole returned to the vertical. The load was then applied with a view to destroying the pole. A definite yield point appeared at a load of about 1,100 lb., and deflection of 14 in., and the pole finally gave way under a load of 1,500 lb., the deflection at final failure being 36 in. Failure occurred by crushing of the concrete between the joists and bending of the joists at the ground line, where the pole was firmly clamped. These tests indicate that the pole has ample strength and elasticity and that the design is properly proportioned. In practice the earth would doubtless give way at the pole foot under excessive strain, so that the pole itself would sustain little damage.

Schedules I and II give the estimated costs of two types of line construction using Stobie poles, compared with the costs of wooden pole constructions for similar service.

Schedule I

Estimated capital cost and annual charges on low tension distribution line 1 mile long.. Spacing of poles 2 chains.
(Insulators and conductors not included).

Capital Cost

Steel and concrete pole line, poles 29 ft.—	
40 poles erected at £5	£200 0 0
Road metal at 1/6 per pole	3 10 0
40 steel crossarms	6 17 0
Erecting crossarms at 1/3	2 10 0
Capital cost per mile	£212 17 0
Wooden pole line, poles 30 ft.—	
40 poles erected at £3/10/-	£140 0 0
40 Karri crossarms, 5 ft. 7 in. at 2/3	4 10 0
Erecting crossarms at 1/6	3 0 0
Capital cost per mile	£147 10 0

Annual Charge

Steel and concrete pole line—	
Interest on £212/17/- at 6% for 45 years	£574 13 0
Cost of replacement at end of 45 years	£212 17 0
Plus 25/- per pole extra*	50 0 0
	£262 17 0

Amount to be set aside annually and accumulated at 5% compound interest to provide for the cost of replacement at end of 45 years = £1.64. £1.64 per annum × 45 years	73 15 0
Total charge for interest on original capital and replacement	£648 8 0

Expense for 1 year—£14/8/- per mile of line.

Wooden Pole Line—	
Interest on £147/10/- at 6% for 45 years	£399 0 0
Cost of replacement at end of 15 years	£197 10 0
Amount to be set aside annually and accumulated at 5% compound interest to provide for cost of replacement at end of every 15 years = £9.26. £9.26 per annum for 45 years	416 14 0
Total charge for interest on original capital and replacement	£815 14 0

Expense for 1 year—£18/3/- per mile of line.

Comparison

Wooden pole line	£18 3 0 per annum
Steel and concrete pole line	14 8 0 per annum

Saving per mile in favor of steel and concrete poles £3 15 0 per annum
Capitalising this at 6% interest, 3.75

$\frac{3.75}{6} \times 100 = £62/10/-$ per mile of line, which

approximately represents the advantage as regards capital in the use of concrete steel poles for this purpose = £1/11/3 per pole.

Schedule II

Comparative Costs and Annual Charges of Stobie Poles and Wooden Poles.

Transmission line 33 kv.a. 3 phase, 50 periods, 2 circuits, 42 ft. 6 in. poles in each case. (Omitting conductors.)

Cost per mile

Concrete and steel poles 9 per mile. Conductors 5 ft. spacing:—	
9 poles erected at £9/6/- each	£83 14 0
9 crossarms, 16 ft. 6 in. long attached at 16/-	7 4 0
9 crossarms, 11 ft. 6 in. long attached at 10/-	4 10 0
54 insulators at 5/- each	13 10 0
54 insulator pins and bolts at 3/1	8 6 6
18 crossarm braces, 4 ft. 9 in. long at 1/1	0 19 6
18 crossarm braces, 3 ft. 9 in. long at 9d.	0 13 6
18 crossarm supports at 4/-	3 12 0
	£122 9 6

Wooden poles, 12 per mile. Conductors 4 ft. 6 in. spacing:—

12 poles erected at £6/15/- each	£81 0 0
12 crossarms, 14 ft. 0 in. long attached at 13/8	8 4 0
12 crossarms, 9 ft. 6 in. long attached at 8/10	5 6 0
24 crossarm braces at 1/1	1 6 0
24 crossarm braces at 9d.	0 18 0
72 insulators at 5/- each	18 0 0
72 insulator pins and bolts at 3/1	11 2 0
Extra bolts for crossarms at 2/- per pole	1 4 0
	£127 0 0

Annual Charges

Concrete and steel pole line, 1 mile—	
Interest on £122/9/6 at 6% for 45 years	£331 0 0
Cost of replacement at end of 45 years	£122 9 0
Plus 25/- per pole extra*	11 5 0
	£133 14 0

Amount to be set aside annually and accumulated at 5% compound interest to provide for cost of replacement at end of 45 years = 16/10. 16/10 for 45 years	37 12 0
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Total charge for interest on original capital and replacement	£368 12 0
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Expense per annum, £8/3/10.

Wooden pole line, 1 mile—	
Interest on £127 at 6% for 45 years	£343 0 0
Cost of replacement at end of 15 years	£127 0 0
Plus 25/- per pole extra	15 0 0
	£142 0 0

Amount to be set aside annually and accumulated at 5% compound interest to provide for cost of replacement at end of every 15 years, £6/11/- £6/11/- at 5% for 45 years	294 0 0
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Total charge for interest on original capital and replacement £637 0 0
Expense per annum, £14/3/-.

Comparison

Wooden pole line £14 3 0 per annum
Steel and concrete pole line 8 3 10 per annum

Saving per mile in favor of steel and concrete poles .. £5 19 2 per annum

Capitalising this at 6% interest, 5.96

$\frac{5.96}{6} \times 100 = £100$ per mile of line, which

approximately represents the advantage as regards capital in the use of concrete steel poles for this purpose = £11 per pole.

*Cost of replacement taken to be greater than original cost by 25/-.

The Development of Electricity Supply in Perth, W.A.*

By T. M. Carey, M.Inst.C.E., M.I.E.E.

Historical.—The earliest attempt at public electric supply in Perth was made in 1888, when a small steam engine and dynamo were erected in premises in Hay street between Pier and Barrack streets, and a few consumers were connected. The venture, however, was not a financial success and did not operate for very long.

In 1892 the Perth Gas Co. obtained parliamentary powers to supply electricity, and erected a plant consisting of a 100 h.p. horizontal steam engine and two 24 kw. 110 volt dynamos. The three-wire system of distribution was adopted, and cables were erected on jarrah poles in several streets. Consumers paid one shilling per unit for current. The plant was run from sunset until midnight, and the company lost money on the business for the first three years.

In 1896 the company installed a new plant. The plant consisted of three Babcock and Wilcox boilers and four Willans central valve steam engines coupled to Castle dynamos, each of 44 kw. capacity, and a small storage battery. The next addition to the plant was made in 1899, when two similar machines, each of 110 kw. capacity, were installed and the supply voltage was raised to 220 volts, the old machines being fitted with new field coils and armatures.

The records show that even at this early date loads grew quickly and, pending the installation of this plant, the company was refusing new consumers. Up to this time no condensing plant was installed, but a year or two later a triple expansion Willans-Dick Kerr set was erected with a surface condenser and steam driven auxiliaries, and more Babcock and Wilcox boilers were added. One of the faults of this plant was that the circulating pump was of the reciprocating type, and the intermittent pressure on the water caused breakages of the condenser ends and other parts. As the demand for power and light increased it was decided to secure a larger site for the next extension, and land was purchased in Marquis street, West Perth, where three more Willans 500 kw. sets and one similar set of 400 kw. were erected between 1905 and

1912. The Babcock and Wilcox boilers for this plant worked at 200 lb. steam pressure and the surface condensers were equipped with electrically driven centrifugal circulating pumps and Edwards' air pumps.

In 1909 the Perth city council decided to exercise its powers under the Perth Gas Company's Act, 1886, and purchase the whole of the plant and rights of the Perth Gas Co. This decision led to long-continued and expensive litigation, as the company was not anxious to sell and demanded payment for goodwill in addition to plant. This the council refused to pay, and their action was upheld by the high court. The gas company, however, appealed to the privy council, and won the case, and the council completed the purchase in February, 1912, paying £478,000 for goodwill and plant. This action of the Perth city council was very much criticised, as both the electric and gas plants were becoming overloaded and were obsolete and further heavy expenditure was necessary.

About the same time the state government resumed, for future railway extension purposes, the power station and land at Marquis street, but arrangements were made for the council to remain in possession until a new station was built.

Combined City Council and Government Power Scheme.—In 1913 the state government, whose tramway power house was old and inefficient, decided to build a new plant, and negotiations with the Perth city council resulted in the decision to build one station to supply both parties, whose demands were about equal, and who would thereby obtain cheaper power. This decision was confirmed by the Electric Light and Power Agreement Act, 1913, and the government retained Messrs. Merz and McLellan as consulting engineers to design and supervise the construction of the plant. Briefly stated, this act provided that both parties should obtain power at cost price, which included all capital charges, that the government should operate the plant, that the council should have the right of inspection, that the cost to the council must not

*Chairman's inaugural address, Perth Division, Institution of Engineers, Aust.

exceed .75d. per unit, that power must not be obtained from any other source for 50 years, and that the government must install new plant when required to meet increased demands of the council of which notice had been given.

The power house was constructed to one of Messrs. Merz and McLellan's well-known designs, and generates three-phase alternating current at 6,000 volts, 40 cycles. At the present time three turbo generators of 4,000 kv.a., and one of 7,500 kv.a. are in operation, and large additions to the plant have recently been put in hand. Collie coal is used exclusively.

able. Much has already been done in this direction on the Continent and in the Dominions. The electricity commissioners in South Africa and Victoria, for example, have both made this part of their general policy. In Great Britain also, a good deal has already been accomplished in certain districts. The electricity commissioners are endeavoring to promote standardisation and the railway electrification committee has recommended a standard of 50 cycles."

The bulk supply to the city council is given at four main substations served by a 6,000 volt underground ring main with the Merz-Hunter

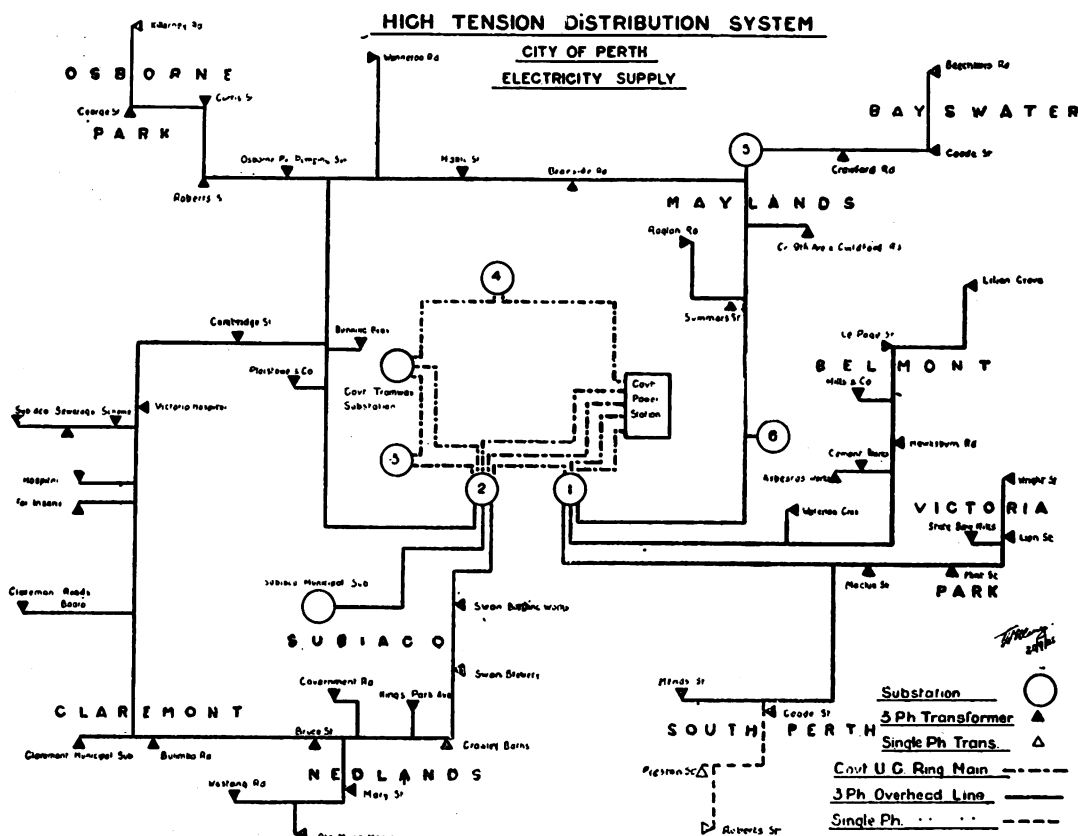


Fig. 1

The decision to generate at 40 cycles was made by Messrs. Merz and McLellan and was undoubtedly a serious error. As 40 cycle systems are not standard and nearly all Australian plants installed prior to the Perth plant generated at 50 cycles, electrical plant for Perth has to be specially made, costs more and takes longer to procure. It is very desirable, in the interests of economy and convenience, that standardised voltages and frequencies should be adhered to. This fact is now realised by Mr. Merz himself who, in his address on Transmission and Distribution of Electrical Energy to the world power conference last year, said:—"Where alternating current is used for electric power distribution the standardisation of periodicity is very desir-

split conductor system of protection, which instantly isolates a faulty cable by opening switches at each end without interrupting the supply to the substations. The ring main and the switches controlling it are the property of the government.

The city council decided, on the advice of its engineers, that when alternating current was available the supply throughout would be changed from 440 and 220 volts direct current to 440 volt three-phase and 250 volt single-phase alternating current, and converters were therefore not required.

At each of the four main substations the high tension current passes through a bulk supply switch and metering panel to the main bus bars.

Three meters are used to check one another, and these are carefully calibrated to ensure accuracy. The switchgear controlling the step-down transformers and the ring main cables is Metropolitan-Vickers heavy duty type, erected in brick and concrete cubicles with steel mesh doors interlocked with the oil switches and isolaters. This arrangement makes it impossible to open any cubicle or bus bar chamber door until the switches are open and all conductors in that cubicle are dead. Conversely, no cubicle can be "livened up" until the door is closed and locked. The transformers are placed in fire-proof chambers with sufficient headroom in each to lift any transformer out of its tank and ample provision for ventilation.

The low tension switchboards, consisting of transformer and feeder panels, are built over cable troughs from which the feeder cables pass out underground, either through ducts or tunnels, to the street.

High tension feeders are controlled with iron-clad draw-out truck type switches. These are both safe and convenient for cleaning and repairs. The high tension cables are taken out underground. In the No. 2 substation the growth of the load and the larger transformers now in use have made it necessary recently to provide a special floor for low tension transformer switches. These are remote controlled from the feeder switchboard floor. Transformers in all the main substations are fitted with Merz-Price balanced protective gear. The smaller substations are connected to overhead lines controlled at the main substations.

With the idea of giving better service from unattended substations it has been decided to install automatic reclosing gear on low tension feeder switches, and one substation will be so equipped very shortly. This apparatus will reclose a switch which opens on overload up to three times with short time intervals. If on any of these attempts to restore the supply the overload has vanished, the switch remains closed and the gear re-sets itself for a similar cycle of operations on the next necessary occasion. If the short circuit or overload remains, the switch is locked open after the third time of closing.

Changeover to Alternating Current.—The decision to change from direct to alternating current entailed a large amount of work, which was rendered more difficult by the war conditions then existing. As this is believed to be the largest system in Australia which has been completely changed from direct current to alternating current, and some of the work involved was unusual, a description of the methods adopted will perhaps be of interest.

After the changeover was definitely decided upon a notice to this effect, and stating that the council would be willing to change motors

and other apparatus not suitable for alternating current, was sent to each consumer. An agreement form which the consumer was required to fill up and sign was sent to all power consumers and large lighting consumers. As soon as these agreement forms were returned, technical details of motors, arc lamps and other apparatus in use by the consumers were obtained and recorded by draughtsmen on cards. Notes were made regarding the use of standard or special a.c. motors. Wherever possible standard motors were used, squirrel cage motors being used for all the smaller sizes. Details of a.c. motors required to replace the d.c. motors were then filled in on the same cards, and connection diagrams or plant lay-out sketched and dimensioned on the back of the cards when required.

It was originally intended that all motors below 2 h.p. should be single-phase and those of 2 h.p. and over, three-phase, to save the cost of rewiring the small motors. On account of the bad starting torque of many of the single-phase motors, however, a large number of three-phase motors were ultimately installed below 2 h.p.

In ordering motors, the sizes were standardised as far as possible to limit the number of different sizes of motors. The standard sizes selected were $\frac{1}{2}$, 1, $1\frac{1}{2}$, 2, 5, 10, 15, 20 h.p. and larger sizes. 3, 4, and $7\frac{1}{2}$ h.p. sizes were not considered necessary, and the nearest standard size of a.c. motor was supplied to a consumer in each case.

From the motor card index, lists of a.c. material required were made up and contracts let. The chief contracts let were as follows:—Two for motors; two for house service meters; one for underground cable; one for switchgear; one for transformers; one for elevators.

It was at first thought it would be necessary also to change incandescent lamps. It was later decided, however, that this would not be necessary, and incandescent lamps were not changed. When the a.c. supply was first given the voltage was kept low by choosing a suitable tap on the transformers. The voltage was raised gradually as the old lamps burned out.

To convert passenger and goods elevators for a.c., it was necessary to install new motors, controllers and brakes. As soon as quotations for new apparatus were obtained, estimates were prepared of the complete cost of changing over each elevator. As many of the machines were very old, the owners were notified that, if they wished, the department would pay to them an amount equal to the estimated cost of installing new motor, brake and controller upon the consumer installing a complete new a.c. machine. In a number of cases the offer was accepted and the council relieved of the responsibility of carrying out the actual changeover of the elevator.

The first area changed was Maylands, where alternating current was supplied on February 19, 1917.

Before a changeover was started in a given area, meter boards and motor circuits were re-wired and a.c. motors and meters were delivered and all preparatory work done. The power consumers were notified of the day and time when power would be cut off. On the day of the change new motors were connected by the fitters and the line gangs cut away the d.c. feeding points. The a.c. feeders, which had previously been connected to the mains, were then switched in at the substation. It was usually not necessary to keep the overhead distribution mains

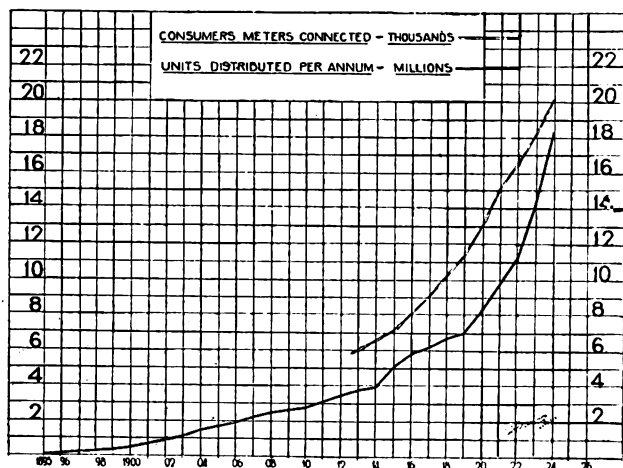


Fig. 2

dead for more than about half-an-hour. Immediately the a.c. was switched on, meter men started installing a.c. meters, testing to earth in each case to make sure of the neutral being run to the correct meter terminal. D.c. meters were not removed until after the a.c. was switched on, as it has no detrimental effect on d.c. meters. The man installing the a.c. meter removed the d.c. meter and made records of the index reading of each. For this purpose the meter men were provided with books. These books were returned each day and a new one taken out, so that the entries made by a meter man one day were recorded in the office the following day.

As no complete record had previously been obtained regarding fans used by consumers, these were not changed until after the a.c. supply was given. The fans in use were recorded by the meter fixers, and these were changed as early as possible afterwards. Many d.c. desk fans were converted for use on a.c.

Owing to war conditions delaying delivery of much of the necessary material, the changeover extended over some years and alterations made by the consumers to their apparatus rendered early details collected unreliable, and towards the end of the changeover all remaining d.c. appar-

atus had to be re-inspected before the changeover could be effected. For this purpose special forms were used. This avoided mistakes in delivery of a.c. apparatus immediately before the changeover. D.c. motors brought in were cleaned, overhauled and adjusted ready for sale. The condition of each motor on reaching the repair shop and after overhaul and other details were recorded on cards.

Plans of the new distribution system were prepared to a scale of 200 ft. to the inch, showing feeders and distributors with details of cable sizes. Much heavy copper had to be removed, as the d.c. power supply was given from three power stations and the a.c. from five substations, none of the localities coinciding except No. 1 power station and No. 1 substation. By carefully selecting the areas in the best order for changing, it was possible to erect all the heavy feeders with copper previously used for d.c. with a minimum amount of spare cable.

Previous to the changeover in a given area, a fourth wire was run in main distributing streets, sizes of cable altered where necessary, and feeders erected and connected through overhead feeder boxes to the network. In side streets where no motors were connected, single-phase was run from the neutral and one-phase wire in the three-phase streets. While the d.c. supply still continued it was usual to connect the fourth wire with the positive or negative outer at the feeder box and transfer thereto portions of the load. This somewhat upset the d.c. balance for a short period, but gave a better balance on the a.c. when first switched on. The balancing of the load over the three phases was completed as early as possible after the changeover.

Plans showing the new distribution lay-out were issued to mains' foremen, together with schedules giving sizes and lengths of copper to be dismantled and erected in each street or section of street. The plan showed open and connected points of the network. Programmes were also issued giving mains' men the order in which feeders and distributor circuits were to be changed and the method of disconnection and connection of old and new supply points respectively.

The changeover was begun in the outer suburbs, where comparatively large areas were changed in one day; but in the centre of the city, where numbers of motors were connected and lighting in large buildings was very important, the change was reduced to a single feeder, or, in some cases, a single distributor circuit from one feeder box, and consumers were without light for a very short time only. Many difficulties were encountered, and special methods had to be devised in some cases, but on the whole the changeover was effected with very little inconvenience to the public.

The consumers' apparatus changed was as follows:—Industrial motors, 917; passenger and

goods elevators, 99; fans (converted for a.c. or replaced), 1,466; No. of meters connected at completion of changeover, 15,000.

Area of Supply.—The Perth city council's area of supply is a circle of five miles radius from the town hall, but in some directions rights have been obtained to exceed this distance.

The 6,000 volt system is shown diagrammatically in Fig. 1. The ring main is 3-core split conductor armored cable laid direct in the ground and covered with an 8 in. x 2 in. jarrah plank for mechanical protection.

The high tension feeder cables are carried underground for a short distance from the substations and then up convenient poles to dividing boxes, where connections are made to overhead lines. As the city grows and higher buildings are erected some of these lines will be replaced by underground cables. These lines are interconnected to form rings where possible, so that repairs can be carried out without cutting off the supply to consumers.

Transformer stations are connected at intervals along these lines to serve areas beyond the reach of low tension feeders from the main substations. Transformer stations, having a capacity of 200 kv.a. and over, are small buildings of brick or fibrolite, housing transformers and switchgear. The transformers are protected on the high tension side by automatic overload oil switches and on the low tension side by automatic oil switches or fuses. Transformer stations up to 150 kv.a. are of the outdoor type. Usually three single-phase transformers are erected on an H pole with protecting fuses on high tension and low tension circuits. Three-phase pole-type transformers are now being used up to 50 kv.a. The low tension fuses which have heavy self aligning contacts are mounted on a slate board in a fibrolite cabinet under the platform, which is 12 ft. 6 in. above the ground. The two or more outgoing circuits are independently fused.

The high tension fuses are of a special type, designed and made departmentally. Connecting ferrules of brass are cemented to opposite ends of a porcelain tube 18 in. long and 1½ in. diameter, and the upper end of the tube is closed with a screwed cap after the fuse wire is inserted. The tube is lined with a soft insulating material, and does not break even when an 18 s.w.g. copper wire fuse is blown on 6,000 volt circuits. The fuse holder is easily placed in position or removed with the contacts alive by using a long insulating handle with a spring clip. This fuse, of which several hundreds are in use, has proved most economical and convenient.

The H poles are built to a standard design, cost little and give excellent service. Transformers are easily changed and larger ones placed in position as the load grows, and this practice is followed to minimise core losses. Pole top switches, also designed and made departmentally

at a low cost, are installed at frequent intervals along the lines to facilitate cutting out sections required dead for any purpose. These triple-pole switches are provided with arcing horns and are operated by the movement of a lever near the base of the pole which can be locked in open or closed position. Lightning arresters of the compression gap type are mounted on each outdoor transformer pole and connected to the 6,000 volt terminals.

Low tension feeders from the main substations terminate in feeder pillars or boxes. From substations 1 and 2 the feeders are underground, each being composed of two 4-core .25 sq. in. cables, and the pillars are Henley five-unit type with 300 amp. fuses having self-aligning contacts. Tests show that these fittings will carry 300 amps. over long periods without overheating

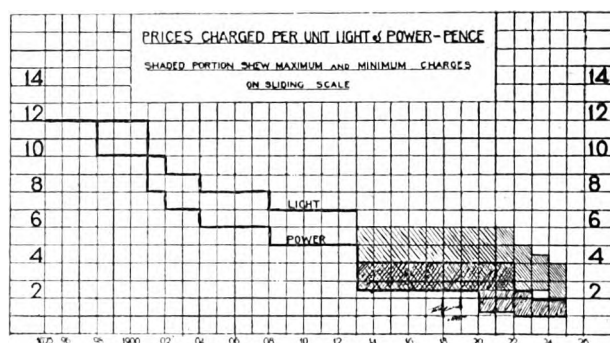


Fig. 3

the spring contacts. Short lengths of cable are run from these pillars up adjacent poles and connect to the aerial distributors.

The first feeder cables laid were armored and placed direct in the ground (sand) and covered with an 8 in. x 2 in. jarrah plank, but recently a system of manholes, tunnels, and ducts was laid down and additional cables, lead-covered without armor, have been drawn in. Ample ducts have been provided, so that in the sections dealt with to date the streets will not have to be opened again to lay feeder cables for many years.

In the first underground section running east from No. 2 substation, so many cables had to be provided for that serious overheating would have taken place when they were all installed if small ducts were used placed close together. It was therefore decided in this section to construct a brick and concrete tunnel 5 ft. 6 in. x 4 ft. 6 in. and remove the heat by artificial ventilation when the load warranted that being done. All ducts and tunnels are laid to grade, and provision has been made for drainage and ventilation of the whole underground system.

The material used for the ducts was fibre conduit 3 in. internal diameter for No. 1 substation area, and Hume reinforced concrete pipe

4 in. internal diameter for No. 2 substation area. The two classes of duct were used partly in order to obtain earlier delivery than was possible if Hume pipe had been used throughout, and also because the fibre duct was known to be thoroughly satisfactory and the Hume pipe was a comparatively new and untried product. The fibre tubes have male and female ends, and the joints are made by dipping the ends in hot bituminous compound and pressing together. The concrete pipes were jointed by slipping the ends into light galvanised sheet iron ferrules and then surrounding the joint with concrete. Both classes of duct were laid direct in the sand with a protecting slab of concrete 3 in. thick covering them. In sections where a large number of ducts were required they were placed in two vertical rows to allow for the dissipation of heat from the cables. The cost of the two materials was almost the same per foot, and the Hume pipe has proved very satisfactory in every way. Each length was scraped and inspected internally before use, and although it was at first thought that the friction of the lead on the concrete would make drawing in difficult, this was overcome by coating the cable with a mixture of petroleum jelly and paraffin wax.

The cost of the ducts in the ground, including manholes and resurfacing of pavements, was 4/3.7 per ft. The total length at present laid is 55,000 ft.

From substations 3, 4, and 5, feeders are overhead and terminate in overhead cast iron feeder boxes built around steel poles about 20 ft. above ground. On each of the four sides of the box a door gives access to three fuses and a link.

All distributor cables at present are overhead, but the matter of undergrounding them in the main city streets has received considerable attention and will probably be proceeded with in the near future.

Jarrah poles are used almost exclusively for suburban overhead work, and steel poles are used jointly with the government tramway department in the city.

All consumers' connections are metered with the exception of telephone cabinets, which are lighted under contract, both single-phase and three-phase meters being used.

Street lighting in the outer suburban areas is carried out with constant potential lamps and time switches, but in the central areas 6.6 amp. series circuits are used with constant current transformers. This latter system gives good lighting with every lamp and lower costs for current and lamp renewals. With the so-called constant potential system, lamps far from the transformer station become very dull.

General Growth of System.—In recent years there has been rapid and considerable growth in the number of consumers and the units distri-

buted, as shown by the curves, Fig. 2, while the prices charged for both light and power have been regularly decreased. Fig. 3 shows the prices charged since 1895. In 1913 a sliding scale was introduced to lower the prices to the consumer as the consumption increased. The maximum and minimum prices are indicated by the upper and lower lines of the shaded areas. Prices are now so low that electric power is used universally for industrial purposes and is being very largely availed of for domestic heating and cooking. It is certain that the system will continue to expand, and all new work has been planned and carried out with a view to future extensions and additions.

The electricity department of the Perth city council, notwithstanding its low charges, is a profit-earning undertaking and is a considerable asset to the ratepayers.

SELLING ELECTRIC COOKERS

The value of publicity, particularly when prices are right, in selling electrical apparatus has recently been strikingly exemplified in the town of Great Yarmouth, England. The town council reduced the price of electrical energy for cooking to 1½d. per unit. At about the same time an electrical exhibition (the best form of advertising) was held. The result was that, in a town of about 60,000 inhabitants, 230 electric cookers were sold in 10 days.

LARGE RAILWAY UNDERTAKING IN DIFFICULTIES

The Chicago, Milwaukee and St. Paul, one of America's premier railroads, is in the hands of receivers. The company has been one of the most progressive railway operators in the United States, its principal achievement being the electrification of the longest stretch of main line in the country. This line, which is well known to electrical engineers, crosses the Rocky mountains, connecting Seattle with the east. Unfortunately the expectations of the company regarding development in the north-west have not been fully realised, consequently the line has not been able to pay its way. There are two older railroads paralleling the Chicago, Milwaukee and St. Paul's tracks, and the amount of traffic does not yet justify the service. The electrification of the mountain section has undoubtedly staved off the hard times for much longer than would have been the case had steam traction been adhered to. This is revealed by statistics showing a net economy of nearly 80 per cent of the cost of the changeover since 1916. But though electricity helped it could not save what was really an unnecessary enterprise.

The Lake Margaret—Zeehan Transmission Line, Tasmania

By C. E. Bisdee*

The hydroelectric department of Tasmania has erected a transmission line from the Lake Margaret power station of the Mount Lyell Mining and Railway Co., to a point near Zeehan, with the object of making electricity available in this part of the mining field. For the time being power will be taken from the Lake Margaret power station until the growth of business on the west coast demands further hydroelectric development. A 44,000-volt system was chosen in view of likely extensions to the more distant parts of the mining fields, and the possibility of linking in with the north-west coast 44,000-volt transmission system in the future. Work was commenced on the surveying and clearing of the route early in 1924.

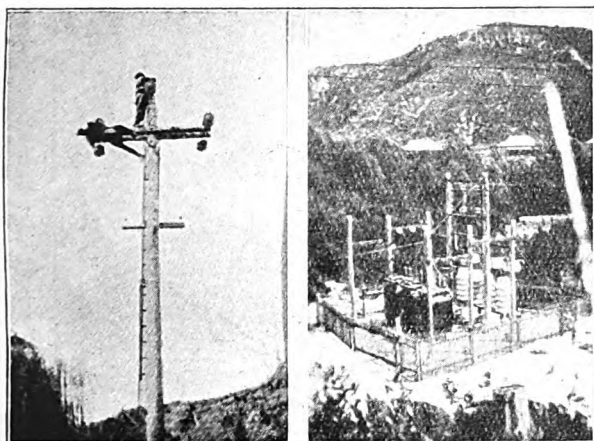
The line, which is 13 miles in length, passes through virgin country consisting of seven miles of button grass plains, four miles of light timber,

all materials, provisions, etc., had to be transported by means of pack horses. In designing the line a high factor of safety was taken in the conductors. This was considered advisable owing to the difficulty of expedient transportation in case of a line failure, the necessity of continuity of supply for this class of work, and the danger of contact with the telephone wires which run directly underneath the power conductors on the same poles. Owing to the short life, which is so characteristic of mining fields, the line was constructed as cheaply as possible, yet consistent with good engineering practice, so that it will pay for itself in the shortest number of years.

Wood poles were chosen in preference to steel towers. The poles were of either gum or celery,† 35 ft. in length, sunk 6 ft. in the ground, and charred and tarred 18 in. above and below ground level. The gum poles give an average life of eight years and the celery of 14 years. The main conductors consist of seven strands of .064 in. copper cable spaced four feet in the horizontal spacings used on short spans over flat country, and eight feet equally spaced in the triangular spacings, used on long spans over rough country where ample ground clearance can be obtained. In flat country, using the horizontal spacing, the standard span is four chains, giving a minimum clearance of 24 ft. from ground. The spans, however, vary from 100 to 600 ft. 44,000-volt pin insulators are used on suspension poles, and small angles, and T.D. suspension insulators are used on strain poles, long spans, and large angles. Telephone lines consisting of No. 12 G.I. wire are strung on 3 ft. 6 in. horizontal spacing, 7 ft. 6 in. below the main conductors. The main conductors are transposed in three equal places throughout the line, and the telephone conductors transposed every quarter mile. Drainage coils, insulating transformers, and the necessary protective gear, are installed at both ends of the telephone line.

The outdoor substation at Lake Margaret power station consists of three 1,170 kv.a. single-phase oil cooled Metropolitan-Vickers transformers, stepping the voltage up from 6,600 to 44,000. The outdoor substation of the Electrolytic Zinc Co., near Zeehan, consists of three 333 kv.a. single-phase G.E. of America transformers, stepping the potential down from 44,000 to 425 volts. A spare transformer is kept at each substation. Oxide film lightning arresters are installed at both ends of the line.

The electrical connections are:—Delta l.t., star h.t., with neutral grounded, at Lake Margaret substation, and delta h.t., star l.t. with neutral grounded at the Electrolytic Zinc Co.'s substation.



Left: Strain Pole, showing Telephone Line.. Right: Hydroelectric Department's Substation at Lake Margaret

and two miles of densely wooded forests, with thick undergrowth. The vegetation consists chiefly of myrtle, sassafras, featherwood, celery and horizontal, making a practically impassable scrub. During the year 1924, 120 in. of rain fell in this part of the district, and great difficulty was experienced in getting men to work under such severe climatic conditions. The route was cleared two chains wide, and a track made for patrolling purposes. Owing to the soft nature of the surface most of the track is corduroy. The line crosses five rivers, over which bridges had to be erected, and special precautions were taken against flood damage.

In October, 1924, the erection of the line was commenced by contract, and on March 6, 1925, the line was put into continuous operation. Owing to the rough configuration of the country,

*Hydroelectric Department, Hobart.

†Gum: Eucalyptus Haemastoma. Celery: Phyllocladus Rhomboidalis.

Fig. 1. Plan High Tension Mains: Barren Jacy Hydroelectric Development

The Barren Jack Hydroelectric Scheme

By H. G. Carter*

The Burrinjuck or Barren Jack reservoir has been constructed to conserve the waters of the Murrumbidgee river, primarily for irrigation purposes in the Riverina district of New South Wales. The water is impounded by a concrete arch dam 220 ft. in height with a crest length of 784 ft. When full, the reservoir holds 209,500 million gallons, and the river is backed up for 41 miles. The water is supplied to the irrigation areas, some 200 miles downstream, and the

tion from the dam. The public works department has the work in hand and it is expected that supply will be available early in 1926.

Power Station

A portion of the discharge from the dam will be led through a 7 ft. diameter steel pipe (Fig. 3) supported on concrete footings, to the power station. The station will be a reinforced concrete structure situated about 1,500 ft. down the river from the dam, and the initial installation

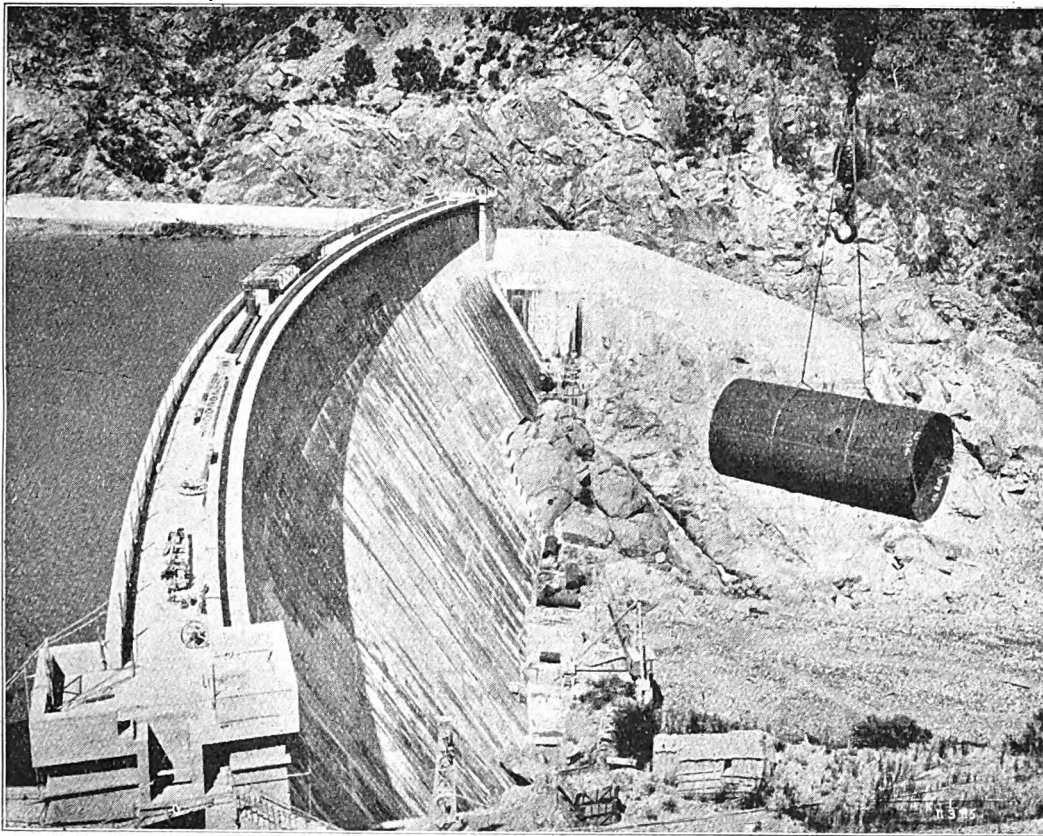


Fig. 2. General View of Barren Jack Dam showing Pipe being lowered to River Bed

function of the dam, therefore, is to store water during the winter months and to release it during the summer in accordance with the irrigation area's requirements. During the winter, however, sufficient water has to be released to preserve the rights of property holders along the river below the dam. This makes possible a hydroelectric development which is capable of supplying a continuous all-year demand. The New South Wales government has accordingly designed a scheme to make use of the continuous discharge for supplying electrical energy to the towns within the radius of economical distribu-

tion will consist of two Francis type vertical water turbines each direct-coupled to a 5,000 kw. alternator. This station will provide for the maintenance of an output of 5,000 kw. throughout the system, one generating set being kept available for emergency purposes. Current will be generated at 6,600 volts and stepped up, by transformers situated adjacent to the power station, to 66,000 volts, at which pressure power will be supplied into the transmission line system. The amount of water which has to be released for maintaining the stream flow is sufficient to ensure an output of 5,000 kw. throughout the whole year. The immediate expected demand from the

*Chief engineer of Public Works, N.S.W.

towns to be connected is 2,000 kw., so that there is ample power margin available to meet prospective developments for the next few years. It must also be borne in mind that the irrigation area, for which the Barren Jack dam was designed, is only approximately one-third developed, consequently, the dam stores considerably more water than is likely to be required for several years to come, until, indeed, the irrigation area attains approximately its full development. It is unlikely, therefore, that any restrictions will be placed on the use of water from Barren Jack until the irrigation area becomes fully developed.

As soon as the demand for electricity is firmly established and the justification for extensions becomes apparent, it is proposed to use certain tributaries of the Tumut river to augment the supply. These rivers provide a somewhat variable flow, but can be relied upon for a considerable amount of power during the winter months, or at such time as the restrictions are likely to be placed on the output of water from Barren Jack. It is expected that sufficient power will be obtained from these rivers to maintain a demand up to 20,000 kw. during the winter months. There will be no difficulty in extending the Barren Jack power station and obtaining power from the discharged water up to this capacity during the summer months. The combination, therefore, of the waters of the Tumut with the Barren Jack reservoir discharge will enable a total demand of up to 20,000 kw. to be handled throughout the year. There is, therefore, ample provision in the present proposal to meet all likely demands for several years to come.

Transmission System

The transmission system will follow generally the routes indicated on the plan (Fig. 1). The lines will be constructed for the most part with wooden poles, but steel towers will be used on that section of the line in the vicinity of the power house. The lines will be constructed so that the minimum clearance of any conductor to ground will be 25 ft., and the spacing of the poles will be approximately 400 ft. The transmission pressure of 66,000 volts will be broken down, at substations suitably located, to 6,600 volts for supply in bulk to municipalities, pumping stations, etc. The substations will cost approximately £2,000 each, and it is therefore not practicable to break down the current to a convenient voltage for general supply purposes unless a revenue of approximately £500 per annum is available in the vicinity. It must not be thought, therefore, that because the transmission line passes through or approaches any particular property power will necessarily be available.

The lines, as the diagram shows, have been designed primarily on a ring system, so that power may be fed in either of two directions. This arrangement will enable any one section

between two substations to be definitely cut out if trouble develops, while still maintaining the supply to all consumers. Arrangements are also being made to establish direct communication throughout the system with a view to reducing loss of time in handling transmission line troubles. Special care is also being taken to so construct the lines as to avoid interference with local telephone circuits.

Rates of Supply

The charges for bulk supply of energy, a schedule of which has been forwarded to the various interested municipalities, are based on the maximum demand system and are as follow:

Maximum Demand Rate.

- (a) Consumers whose demand does not exceed 150 kv.a. - £15 per kv.a. per annum
- (b) Consumers whose demand exceeds 150 kv.a. - - - -
- For the first 500 kv.a. - - - - - £12 per kv.a. per annum
- From 500 up to and including 1,000 kv.a. - - - - - £10 " "
- All in excess of 1,000 kv.a. - - - - £8 " "

Consumption Rate.

- For the first 500,000 kw.h. p.a. - - - - 0.5d. per kw.h.
- From 500,001 to 1,000,000 kw.h. p.a. 0.25d. " "
- All in excess of 1,000,000 kw.h. p.a. 0.1d. " "

These rates provide for supply at 6,600 volts to consumers on the ring system.

It is not the intention of the public works department to extend greatly beyond the ring transmission system in the first instance, as it is essential to first of all place the scheme on a proper financial footing, and in this regard the bulk of the revenue must of necessity come from the larger towns. Once the financial stability of the scheme generally is assured, lines of a more or less developmental character can be considered. It must be remembered that the bulk of the charges in operating a system of this nature are fixed charges, i.e., the cost per annum will not be greatly different, whether little current is sold or whether the full output from the station is maintained. For this reason the maximum demand charge has been adopted, as the consumer is then directly charged in accordance with the proportion of the amount of plant used rather than on the actual consumption.

Present Position of the Work

Up to March 31, 1925, the greater portion of the main pipeline between the dam and the power station has been erected; the whole of the power station excavations are complete and a

commencement is being made with the building. The generating machinery has arrived in Sydney, together with the whole of the switchgear. The main transformers are shortly due, and an order has been placed with a local firm for a section of the substation transformers. A large proportion of the poles, insulators and copper conductors has been ordered and delivered. It is expected, therefore, to be able to supply current to the nearer townships by March, 1926, and to the more distant townships before the end of that year.

The scheme may be regarded generally as one of great national importance as it will make power available over a large section of the country at comparatively cheap rates. The use of electric power has undoubtedly proved in other countries to be the means of increased

production, which in turn means increased wealth. The co-operation of all consumers is therefore sought in assisting this development. As indicated, the schedule of rates provides for an automatic reduction in the price per unit in accordance with the amount of electricity consumed. The rates are such as should attract industries and generally assist in providing these country towns with a commodity which will, it is hoped, largely check the present drift of population towards the metropolis.

(Since this article was written the dam has been subjected to a severe test. Abnormal rainfall in the catchment area resulted in an immense body of flood waters passing the structure. A considerable amount of damage has been done to the hydroelectric works, but the dam itself is uninjured.—Ed. E.E.)

A Simple Electric Supply Billing System

A simplified method of meter reading and collecting from residential customers which does away with the presentation of monthly bills is used by a municipal electric light and power plant in the United States. By this system 5,000 accounts are handled monthly, a daily balance is taken on customers' ledgers, and the accuracy of the work is proved without error or overtime by two meter readers and one clerk in the office, the clerk operating a Burroughs posting machine and also acting as cashier.

Meters are read continuously throughout the month. There are forty-four routes, and each meter reader covers one route daily. The readers take with them a small slip on which has been addressographed the customer's name and address, also the date due and last discount date. The meter reader places the present meter reading, last meter reading and the consumption on this slip, which he leaves with the consumer. This is the only notice given consumers as no further statement is sent. On the back of the slip is a complete schedule of city light rates, both gross and net. The consumer reads the figures on consumption, turns to the back of the slip, runs down the column until he finds the right amount, and in that way discovers how much, gross and net, he owes for the month.

This slip carries all the information that a customer would receive on a regular statement. He learns from it when the bill is due and how long he can wait to pay it and still get his discount. He either sends in his cheque or steps into the office with the slip and pays his bill.

When the meter reader returns to the office he turns in his route book. The next morning

the clerk who does the billing takes that book and posts the bills for the consumers on that route. The present and previous meter readings, the total consumption, the gross and net amount due and the discount are printed by two operations of the keyboard. The rest of the work of posting the ledger card and the necessary figures on the bill and cashier's stub are done automatically.

While the ledger card and bills are being posted a carbon copy of the figures is being made on a "recap" sheet that is underneath the bill. When the operator fills up one of those sheets she obtains a printed total at the foot of every column on the sheet. That gives her a proof of posting and a quick check on the work she has done. To verify the accuracy of her work the operator adds the total of previous readings to total consumption. The result should be the total of present readings.

The bills after posting are placed in a case at the cashier's cage. When consumers come in with their meter reader's slips the cashier turns to the case, pulls out the bill, stamps it Paid, cutting off the stub, takes the slip from the consumer, and the transaction is closed. In this manner a great deal of expense has been eliminated, and much work which might cause errors done away with. (Electrical World.)

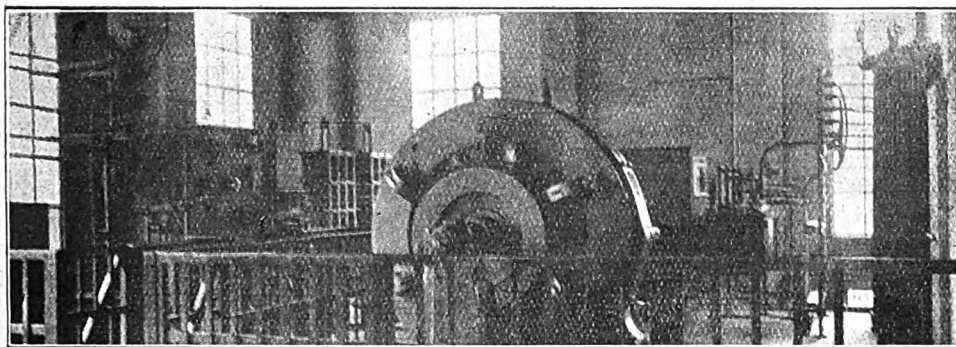
The first power house was erected at Niagara Falls 30 years ago. The installation consisted of three 5,000 h.p. generators. To-day in a near-by power house three units are developing 270,000 h.p., and the total output on the United States side is nearly half a million horse power.

The Reliability and Economy of Automatic Substations*

By A. E. Pell†

The suburban electric railway system of Melbourne has now been in full operation for over two years. It comprises the electrification of 353 single track miles, and 34,000 tons of rolling stock, and the handling of approximately 300,000 passengers daily with 1,100 train journeys. There is a power house of 79,000 kv.a. capacity, three phase distribution at 20,000 volts, 25 cycles, to 18 substations, and rotary converters supplying current at 1,500 volts to the overhead equipment. Of the substations five are automatic. They feed into the 1,500 volt system at distances of from four to seven and a half

current to the majority of the control devices, the remainder being supplied with 250-volt d.c. from the exciter previously mentioned. Other chief features of each unit are oil immersed start and run contactors, a high speed circuit breaker, line contactors and load limiting resistances. A substation is brought into operation by the drop in pressure in the overhead line causing a master starting relay of the solenoid type to open its contacts, thus commencing a sequence of operations which finally results in putting the converter on the line. In the double unit substations the first unit is brought on to



Converter Unit in Automatic Substation

miles from the nearest manually operated substation, maintaining services to and beyond their locality of from 10 minutes during rush hours to hourly during slack periods. There are three double unit automatic substations, erected at Springvale, Mitcham and Reservoir, and two single unit, at Rosanna and Greensborough.

Each unit of the automatic equipment consists of a B.T.H. rotary converter, a G.E. main transformer, and apparatus for operation of the plant. To carry out this operation and thoroughly protect the equipment there are 58 relays or devices to each unit. The rotary converters are fitted with the new B.T.H. blow-out brush gear comprising magnet blow-out brush box, arcing horns on armature, and fan. They have a continuous rating of 1,000 kw., and two-hour rating of 1,500 kw., and are provided with a 250-volt d.c. exciter, primarily to ensure correct polarity whilst the converter runs up and then to supply power to various contactors.

The main transformer is of 1,080 kv.a. capacity, and is connected through an oil switch on its primary side to the 20,000-volt three phase 25-cycle mains. A single phase 110/220-volt 10-kv.a. control transformer supplies alternating

the bus through the load demand. The second or trailing unit is controlled by a current relay, which as in the case of the leader, introduces a time interval. The preference as to leader or trailer in operation is accomplished by means of interchanging their respective master starting relays through a hand-operated drum controller. The second or trailing unit is also shut down as the load diminishes, through its underload current relay which is released by a load of little less current value than that which first brings it into operation.

Protection during the starting period is afforded by a starting protective relay which commences to time immediately the starting switch closes and continues timing until the line contactors tie the machine to the bus. The setting of the relay allows a sufficient time margin for the station to go on the line, the average time being 53 sec. Protection during the running period is provided against the following abnormal conditions:—D.c. overload, a.c. overload, prolonged heavy loading, overheating of main transformer, underload and reverse power, overheating of bearings of pony motor, flashovers, undervoltage, and overspeed. All the protective features apart from those which

*Extract of Paper read before Melbourne Division, Institution of Engineers, Australia.
 †Substation District Engineer, Victorian Railways.

operate during running up only, operate to interrupt either temporarily or permanently the master control contactor. An interlock in this circuit always runs the controller to the off position ready for the next start, a.c. failure alone being the exception to this.

Reliability of Operation

For various reasons, principally because there was generally some 20,000-volt apparatus alive before construction work was complete, the railway department manned the automatic substations during the initial period. Automatic operation, however, was relied on even though the attendant was present. As a matter of fact the attendants were really observers, noting and reporting only abnormal conditions. As is the case in practically all new work, there were minor troubles during the first few months. Some of these are as follow:—

(1) The starting protective relay, being of the oil dash pot type, is subject to considerable variation in its set timing, owing to the wide and sudden variations in our atmospheric temperatures which effect the viscosity of the oil. The effect of the variation can be overcome by giving the relay a longer time setting, but as this relay was the only protection against flashover between brushes this could not be safely done without introducing further protection. The addition of a light a.c. protection during the starting period, however, has removed this responsibility from the starting protective relay and allows of a more liberal setting.

(2) Leakage of oil from bearings by syphoning through the tubes of the thermostats which operate the devices protecting against overheating, has caused a little trouble, but this has been practically eliminated.

(3) The most serious disadvantage in the double unit substations was that should the leader fail due to any reason whatever the substation became a total failure, as the trailer depends upon the output of the substation, and therefore, of its leader, to actuate its current relay to commence its sequence. This has been rectified by the addition of another relay which, should the leader fail or be locked out automatically on power demand, starts the trailer.

(4) Over sensitivity of the reverse power relays caused a considerable amount of trouble. This was due to the fact that the line voltage of the automatic substations varies only with a.c. fluctuations, while that of the manual substations, with which they are paralleled, varies somewhat owing to the human element. The fitting of new springs to the reverse elements of the relays and recalibration to a maximum setting of 60 d.c. amps. has removed all trouble.

These various troubles were only incidental and the general reliability of the plant has in reality exceeded expectations. Table I. gives a synopsis of the operation of the five automatic substations since they were put into commission.

The low percentage of failures is the more remarkable since this type of equipment was new to the staff. Quite a large proportion of the failures were due to the fluctuations in atmospheric temperature, as previously explained.

Table I
Synopsis of Operations

Substation.	Date put into commission.	Operations.	Machine hours.	Hand reset shut-downs.	Per cent failures.
Springvale A. . . .	18/7/23	3,450	11,250	17	0.49
B. . . .	5/12/23				
Mitcham A. . . .	18/8/23	1,812	10,567	5	0.27
B. . . .	24/4/23				
Reservoir A. . . .	1/10/23	1,678	10,595	13	0.77
B. . . .	21/6/23				
Rosanna	14/4/23	1,250	12,960	2	0.16
Greensborough . .	6/7/23	5,665	4,222	5	0.09
Total		13,855	49,592	42	0.356

Economies

The most important part of the maintenance organisation in connection with the automatic substations is the supervision. The distribution engineer, who is responsible for the operation of the distribution system from generation at the power house to delivery at the overhead, has split up the distribution system and plant into three districts. A substation district engineer is responsible for the operation of each district. The district in which the five automatic substations operate also includes four manual substations, therefore five-ninths of the time of the officer for this district is given to the supervision of the automatics. To assist this engineer there is an engineering assistant who, for about 60 per cent of his time, assists in the supervision of the automatic substations. There is also a running maintenance staff of one equipment maintainer and one shift electrician, who are whole time on the running maintenance, adjustments, etc. These latter men work to a roster and their time is occupied in visiting each of the five automatic substations one day every week. They are employed for 8½ hours per day at each substation. In a double unit substation each unit is overhauled once a fortnight. At present the single unit stations receive weekly maintenance, but when a further two single unit substations (which are at present being built for the extension of electrification to Lilydale and Ferntree Gully*) are completed, this same staff will deal with those also, and each of the ten units will then receive the same maintenance.

To draw a comparison with actual labor costs we must consider that if these substations were manned under local conditions, they would require three shifts per day with one man per shift. The wages bill would be £1,002 per annum. On top of this there is heavy routine

*The units in these stations will consist of mercury arc rectifiers instead of rotary converters.

maintenance which averages £600 per annum, totalling £1,602 per annum. As against this for the automatics, there is the full 8½-hour day of two men for 312 days per annum, the wage bill for which is £566. To be added to this there is 64 man days per annum for heavy routine maintenance, totalling £112/8/- per annum. Supervision in the case of the automatics costs £235 per annum more due to the substation district engineer for this district having the added services of an assistant for 60 per cent of his time, for reasons previously explained. There is, therefore, omitting the equal supervision in both cases, a total of £913 per annum for five automatic substations as against £8,010 per annum for the substations manned, showing an annual saving of £7,097, or £1,419/8/- per annum per substation. Actually, however, these substations would have to be manned with third class shift electricians at a cost of £54/14/- per annum per substation more than with fourth class shift electricians on which the figures are based. It must be remembered, however, when considering the economies that a rotary converter does not cost less to maintain in an automatic substation, but there is less heavy plant to maintain, i.e., fewer oil switches, circuit breakers, etc., and for this reason alone maintenance charges are less. Further, the above comparisons are drawn between the existing manual substations of equal or less capacity and existing automatic substations.

Future Developments

Some experiments have been conducted with supervisory control, and in conjunction with the signal and telegraph branch of the railways department it has been established that it is not a difficult or expensive matter to superimpose this control over the existing telephone system. It should perhaps be mentioned that there is an efficient telephone system specially installed, with an automatic exchange at the Jolimont substation, for the electrification. Every point of importance is linked up with this system and also, as an alternative, is in communication with the railways automatic exchange. Supervisory control of the existing and any future automatic substations can be obtained by this means should it be considered necessary.

Drawings have also been prepared for an indicating system to be installed at a remote locality, say the station master's office, to indicate whether the substation is operating normally or abnormally. This system is in course of installation at the Mitcham station as a trial, but if it is decided to install supervisory control any indicating system will be modified and operate in conjunction with same.

Speaking generally, there is not the slightest doubt that the automatic substation operation has proved a success. The human element is eliminated, and it is established that greater

reliability of operation is achieved. Furthermore, a greater degree of protection is afforded. From records and experience there appears no serious reason why substations of large capacity and multiplicity of machines should not be automatic. It appears that the time is not far distant when, owing to economic conditions, the question of conversion of existing manually-operated substations to automatic will be very seriously considered. In this respect the author would mention that the Victorian railway department has in mind the conversion of several substations, and has already called tenders for the equipment to accomplish this at the Glenroy substation. If this conversion be successful, there is little doubt but that others will follow.

RECENT IMPROVEMENTS IN LIFT CONSTRUCTION*

Radical improvements were made in 1924 in the operating characteristics of high-speed elevators. One of the principal difficulties in the past has been that the speed, on any one speed position of the controller, is decidedly variable with the load, being slowest when the motor is hoisting the maximum load and fastest when the motor is being overhauled by the load.

This poor speed regulation has been detrimental in two ways: (1) if the speed under the worst overhauling load is adjusted to a value which is sufficiently safe and conservative, the speeds at balanced load and when hoisting the maximum load will be unnecessarily slow and will result in poor service; (2) it is difficult to land the elevator car at floors with sufficient accuracy, as the operator must manipulate the controller very differently and with good judgment at different loads in order to make proper landings.

The improved system consists, in brief, of a motor and motor-generator, controlled on the Ward Leonard principle but with the novel feature of an auxiliary series exciter by which a considerable degree of compounding can be successfully applied to the main generator to an extent entirely impracticable to apply in the ordinary manner.

Although the system is new, it has already come into fairly extensive use. More than 50 equipments, divided among 12 installations, were in operation at the close of the year and 17 additional equipments were under construction.

The most impressive installation is at 393 Seventh Avenue, New York City, in the building recently completed for the Equitable Life Assurance Society. In this building are 24 equipments of this type, each for a live load of 3,000 lb. at a speed of 600 ft. per min. The motor is of the gearless-traction type, with rope sheave and solenoid brake.

*General Electric Review.

Joint-Pole Line Construction

Major A. E. Ransom, writing in the *Military Engineer*, strongly advocates the use of joint-pole line construction for commercial services. The rapid development during the last decade of urban and rural light and power lines, designated as supply circuits, and telephone and telegraph lines, designated as signal circuits, has

ferent services on the one pole, and that, providing due precautions were taken, a thoroughly reliable and efficient service could be so obtained.

A comprehensive idea of a standard form of construction for joint lines in commercial service may be obtained from the diagram taken from the standard specifications of the Pacific Telephone and Telegraph companies, U.S.A.

Class B construction is defined as covering all supply circuits. Wires carrying alternating current not exceeding 5,000 volts, any phase or frequency, are always placed at the top of the pole.

Class C construction is for all commercial telephone, telegraph, call box or other signal circuits for public use.

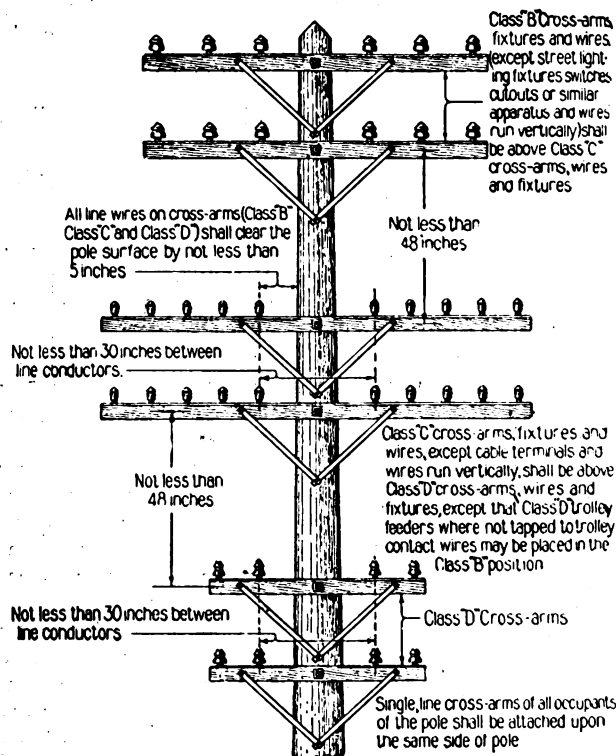
Class D, all 750 volt, circuits for railway trolleys, feeders or power service.

Metallic circuits of two wires, ungrounded, for telephone service on joint lines should be used with protective gaps and ground gaps at each phone. Transposition of wires in each circuit is also necessary at predetermined intervals, dependent upon the voltage of the supply circuits. Insulators instead of porcelain knobs should be used in all joint-like construction. Cross-arms are preferable to brackets on all joint lines, to admit of access to the upper supply circuits by linemen.

A good deal of technical and financial data is now available for those who might desire further details regarding joint-line construction. It is certain that considerable economy in time and material results from the adoption of this system, without any sacrifice in safety, or reliability and efficiency of service. The only real difficulties arise from the diversity of control of the different services, lack of co-ordination between supply and signalling engineers, and a few quite unfounded prejudices.

TUNNEL FOR HYDROELECTRIC SCHEME

Some idea of the magnitude of the Big creek hydroelectric scheme of the California Edison Co. may be gauged from the fact that it has proved economically feasible to drive a tunnel 15 ft. x 15 ft. section, 13 miles long, through solid granite in order to bring water from Florence lake to the Huntington lake storage. The total cost of this tunnel, which was recently completed, including roads, interest, overhead, etc., is said to be nearly three and a half million pounds. The tapping of the new water supply, which this tunnel effects, will obviate the possibility of power shortage such as occurred during the exceptionally dry spell last year. The tunnel at one point is 2,500 ft. below the summit of the mountain range through which it passes. The total head of water to be utilised in five power stations along the Big creek and San Joaquin river is 5,874 ft.



Standard Joint-Line Construction for Voltages not exceeding 5,000

elicited many technical reports on the financial economies in the use of joint-line construction of these two classes of service. For many years, since the introduction of the telephone and telegraph, and of electric transmission lines, there have existed strong prejudices and actual opposition to using the same poles for the two classes of service. This has been due principally to lack of definite technical study and of co-ordination of the engineers representing each class of service.

During the war, in the base ports and intermediate sections of France, many miles of lines, more or less permanent, in that removal was not made necessary until the war was over, were built. Both supply and signal circuits were required and, at many places, much time, material and money were saved by co-ordination of the engineer and signal corps companies by joint-line construction. The experience gained in this work was of value in proving that there was no real foundation for objections to supporting dif-

The Newport Power Plant, Victoria

The juniors' and students' section of the Melbourne division of the Institution of Engineers, Australia, made a tour of inspection of the government power stations at Newport last month. There are two separate stations housed in the one block of buildings: the "A" station, under the control of the railway commissioners, which supplies 25 cycle three phase energy to the traction substations of the suburban electric railways; and the "B" station, under the control of the electricity commission, supplying 50 cycle three phase energy for general power purposes. The engine room of B station is a continuation of that of A, but there is no interconnection of units except an emergency provision for operating the auxiliaries. The three boiler houses are arranged at right angles to the engine room, and that of the B station is entirely separate from those of the A station. Both stations were constructed under the superintendence of Messrs. Merz and McLellan, consulting engineers, and the main parts of the equipment are of similar manufacture throughout. In view of this the installations provide a very interesting comparison of typical generating station practice at different periods. The A station was designed in 1914, and the B in 1922.

The A station has two boiler houses, each containing 12 Babcock and Wilcox marine type boilers of 30,000 lb. per hour individual capacity, arranged in two rows. The steam is generated at a pressure of 210 lb. per sq. in., and superheated to 600 deg. F. Each boiler has two B. and W. chain grate stokers of 84 sq. ft. area, and is worked in conjunction with a Green economiser installed above the boiler. The units are arranged in pairs, each pair served by a single short steel chimney and a Sirocco induced draft fan. The coal is brought in by rail and dumped into hoppers whence it is loaded by gravity into one of three bucket conveyors at each boiler house. Two of the conveyors elevate the coal to the bunkers above the boilers, while the third runs out away from the boiler house to a storage yard. A $4\frac{1}{2}$ ton electric jib crane equipped with a bucket grab runs on the conveyor gantry over the yard and distributes the coal as it is dumped. The conveyor on its return journey travels in a tunnel under the coal storage and is used for returning the coal to the bunkers when required. The coal falls from the bunkers to the grate hoppers through gravity chutes. The ashes fall from the grate backs to hoppers, whence they are discharged through clinker crushers to a pneumatic discharge system which elevates them to the ash storage bunkers, of which there are two for each boiler house. There is one clinker crusher for each row of

boilers, running on rails so that it may be placed under any particular hopper. The steam is taken from the boilers to common headers 13 in. in diameter, one at the back of each row of boilers.

In the B station there are five Babcock and Wilcox steel-cased marine type boilers, each of 43,000 lb. per hr. capacity. Each boiler is served by two B. and W. chain grate stokers of 112 sq. ft. area, chain driven from a line shaft. The steam pressure is 275 lb. per sq. in. and the total temperature between 650 and 700 deg. F. There are no economisers, but each boiler is equipped with a Babcock and Wilcox air pre-heater of 6,950 sq. ft. area. A balanced draft system is used and the flue gases from all boilers are led to a common brick chimney of 12 ft. 6 in. internal diameter, the top of which is 136 ft. above the firing floor. The coal is handled from the receiving hoppers by Fraser and Chalmers belt conveyors, with a capacity of 110 tons per hour, one running over the bunkers and the other over the storage yard. A Babcock and Wilcox jib crane grab is used for distributing the yard coal, and for reloading on to the belt for return to the bunkers. Gravity chutes equipped with distributing gear are used for leading the coal from the bunkers to the grate hoppers. The U.S.C.O. water sealed conveying system is used for ash removal. The ashes fall through hoppers into a water trough in which runs a drag link conveyor which discharges into an elevated hopper over the railway siding.

The engine room equipment of the A station consists of six Parsons turbo-alternators, four of 10,000 kw. capacity and two of 12,500 kw. Each turbine is of the two cylinder tandem compound type, with double flow in the low pressure cylinder, exhausting to twin contraflow condensers of 22,000 sq. ft. cooling surface. The condensers and auxiliaries, including the circulating pump equipment, were manufactured by Messrs. G. Weymouth Pty. Ltd., Melbourne. There are six circulating pumps of 14,000 gal. per min. capacity each, driven by 220 h.p. vertical spindle induction motors. The circulating water is drawn from the river through screens and underground conduits common to both stations. The generating units operate at 1,500 r.p.m., and supply 25 cycle three phase energy at 3,300 volts. This energy is stepped up, in six banks of three each British Westinghouse (now Metropolitan-Vickers) single phase transformers rated at 13,160 kv.a. per set, to 20,000 volts for transmission to the traction substations. The alternators are ventilated by means of fans on the rotors and by independent Sirocco fans drawing the air through wet air filters. The auxiliary services are supplied from step down transformers rated at 400

kv.a., 3,300/440 volts three phase. Each set has its own transformer, and thus operates with its auxiliaries as a separate unit. In addition, however, there is a supply common to all auxiliaries, particularly for those in the boiler house, derived from four 1,000 kv.a. 20,000/440 volt, three phase transformers. In case of emergency the generator auxiliaries may be switched on to this supply. As a further standby, in case of complete shut down there are two house sets, consisting of Parsons turbo-alternators of 350 kw. capacity, which generate at 440 volts, 25 cycle three phase. The turbines of these sets exhaust to atmosphere. The only steam operated auxiliaries are the boiler feed pumps, of which there are four of the Nicholls reciprocating type and four turbine driven Weir centrifugal type. There is no feed water heating except in the Green economisers, and the guaranteed full load steam consumption of the larger turbo-alternators is 11.35 lb. per kw. hr.

The B station section of the engine room contains two 15,000 kw. Parsons turbo-alternators, which, in spite of their greater capacity appear very little larger than the older sets. The alternators are certainly longer on account of the increased output, but the greater power of the turbines has been obtained chiefly by refinements in design. The prime movers are of the two cylinder tandem compound type, exhausting to twin surface condensers of 21,000 sq. ft. total surface, manufactured by G. Weymouth Pty. Ltd. There are two vertical spindle circulating pumps, of 930,000 gal. per hour total capacity, manufactured by the same firm. The generating units run at 3,000 r.p.m., and deliver energy at 6,600 volts, 50 cycle three phase to two Metropolitan-Vickers outdoor type three phase transformers, which step up to 22,000 volts for transmission to the Yarraville distributing station. The A and B stations are only tied together through the frequency changers at Yarraville. Independent fan ventilation through a closed air conditioning system is used for the alternators. The auxiliaries are supplied at 440 volts, 50 cycle three phase from two unit station transformers in a similar manner to those of the A station. In case of emergency an auxiliary supply can be obtained from the latter station through the medium of a frequency changer. The only steam driven auxiliaries are the feed pumps which are of the Weir centrifugal type driven by steam turbines, and have a maximum capacity of 24,000 gal. per hour.

The main point of difference between the A and B stations is in the heat cycle. As previously mentioned the boilers of B station have no economisers, using the general acceptance of the term. Instead, the feed water is heated by means of steam bled from two separate stages of the turbines. Each turbine has two feed heaters through which the condensate passes,

one operating on fairly high pressure steam and the other at a lower pressure. When the turbine is on full load each heater uses 9,400 lb. of steam per hour, and the guaranteed full load steam consumption of the units under these conditions is 10.98 lb. per kw. hr. For purposes of steam consumption tests a pair of weighing tanks are installed in the engine room annexe at the hot well.

The engine room of each station is under remote supervision from separate control rooms, communication with the engine drivers and shift engineers being by engine room telegraph and per telephone. All switchgear in both cases is remotely operated. The main point brought out by a comparison of the two stations is the increased efficiency and the economy of space that have resulted from the introduction of new methods and refinements of design during the last decade.

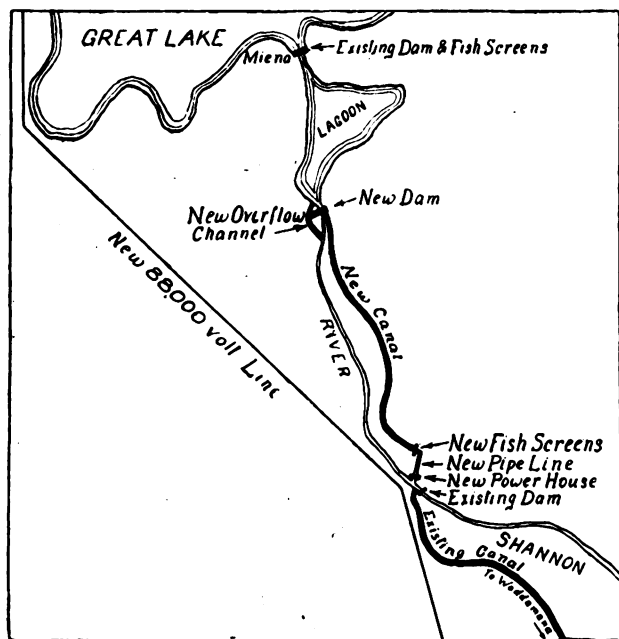
EXTENSIONS TO LAKE COLERIDGE DEVELOPMENT

In connection with the extensions to the hydro-electric plant at Lake Coleridge, N.Z., the first section of the new intake cylinder has recently been placed in the lake. The section is 25 ft. 3 in. long and weighs 18½ tons. It is double walled, with an external diameter of 19 ft. and an internal diameter of 15 ft. The annular space between the inner and outer shells tapers to a point on the outer shell at the bottom end. This end is equipped with a steel cutting edge which will cause the cylinder to sink into the shingle of the lake bed as additional sections are built on to the top. For placing the cylinder a temporary wooden top was built on, making of the annular space an airtight compartment, so that it could be floated into position. The admission of water to this space straightened the whole mass into a vertical position and caused it to sink to the lake bed. As the cylinder sinks with the weight of the additional sections the shingle inside will be excavated by means of an orange peel grab. It is expected that in the final stages it will be possible to pump the water out and allow men to excavate the rock to a firm foundation. When the work is complete the top of the cylinder will be about 10 ft. below the surface of the water. A sub-aqueous tunnel, 13 ft. 6 in. in diameter to connect with the bottom is now under construction.

The Westinghouse Electric and Manufacturing Co. has perfected a disc type thermostat. Applied to an electric iron it maintains the iron at a constant temperature. Over 7,000 hours' continuous service gave no indications of deterioration.

The Shannon Hydroelectric Scheme, Tasmania

In the last number of the *Electrical Engineer* brief reference was made to the new hydroelectric development which the Tasmanian government has in hand. Tenders have recently been called by the hydroelectric department for the construction of the hydraulic portion of the works of the Shannon scheme. The Great Lake is at an elevation of 3,333 ft. above sea level, and at the present time only 1,120 ft. of this head is being utilised. Approximately 250 ft. of



Shannon Hydroelectric Scheme, Tasmania: Locality Plan

head is being lost between the Great Lake and the Waddamana scheme. It is the utilisation of this lost head that will form the Shannon scheme. The sketch plan shows the general arrangement of the work, which presents no unusual features in design or layout.

At the head of the Shannon river an earthen dam 19 ft. high, of standard section, is to be erected. This will divert the waters that would otherwise be passed down the Shannon river through headgates consisting of two radial gates 15 ft. wide by 8 ft. high, passing the water into a canal on the one side. On the other side of the dam will be a construction channel and spillway. The construction channel for diverting the water is necessary in order that the supply may be maintained down the Shannon river for the Waddamana scheme. This channel forms an important feature of the headworks; it consists of a rectangular concrete channel 15 ft. wide, the sides of which act as the abutments of the earthen dam and of the spillway. The

spillway consists of a concrete sill founded on rock with wooden drop boards. Finally, a 15 ft. radial gate will be installed in the construction channel and add to the spillway capacity.

The canal itself will be approximately 2½ miles long, designed to carry 530 cusecs, which represents the average flow of the Waddamana station, with a fair overload capacity. Its dimensions are 15 ft. on the bed width, with 7 ft. water depth and 1 to 1 side slopes, with a 3 ft. freeboard to the top of the bank. Where rock is met with, the section and grade are suitably altered. The upper mile and a half of the canal is of the earthen section, but the lower mile traverses broken country with the steeper grade to increase the velocity, necessitating it being lined with reinforced concrete 3 in. thick. The canal ends at the forebay with a suitable spillway for discharging the water back into the Shannon river, and so on to the Waddamana scheme, without passing through the Shannon turbines.

The forebay is a reinforced concrete structure with a radial inlet gate, log rack, fish screens, scour valve, etc., and forms the head of the pipe line running to the power house. The pipe line will consist of two steel pipes 5 ft. 9 in. in diameter, and will be of the rivetted type or lockbar type, yet to be decided. The power station plant will consist of two 6,000 h.p. Francis turbines direct coupled to alternators, each making with the two pipes complete and independent units. The tail race water from these turbines will discharge directly into the Waddamana canal. The power will be generated at 6,600 volts 3 phase 50 cycle, and will be transformed up to 88,000 volts.

A transmission line is in course of construction from Waddamana to Railton on the north-west coast, with a possible extension to Burnie. As this line passes within half a mile of the Shannon station, the Shannon scheme will tie into it and run in parallel with Waddamana. The high tension portion of the station will be of a semi-automatic character, that is, will be designed to run unattended. An attendant will live in very close proximity to the station, and generally oversee the plant, placing it back on the line should it be thrown off in times of trouble. It will be most essential that this station should have a proportionate output to that of Waddamana so that at all times the water passing through it should be sufficient for the needs of Waddamana station.

The transmission line, under construction, to take power from Waddamana to the north-west coast, will be a steel tower line carrying three 7/097 copper conductors, no earth wire being provided. The country traversed by the line

consists of thirty miles of mountainous country with an average altitude of about 3,000 ft. After traversing the central plateau, the line will drop down to Meander from the Western Tiers, and the next thirty miles is through good agricultural country to Railton. The extension of this 88,000-volt line from Railton to Burnie is under consideration for the supply of power for a new

industry about to be commenced. A substation will be built at Railton to provide a supply of power to the Tasmanian Cement Co. at Railton and to the towns of Devonport and Ulverstone as well as the surrounding district. The country on the north-west coast beyond Ulverstone is to be reticulated from the proposed substation at Burnie.

Water Power Resources of Canada

The Dominion water power and reclamation service of the department of the interior of Canada has recently completed an analysis of the water power resources of Canada, developed and undeveloped as at Feb. 1, 1925. It includes sections dealing with current progress and development, utilisation of developed water power in the central electric stations, pulp and paper, and other leading industries, together with other data of general interest. The steady, consistent growth of water power development in Canada, which was again evidenced during the year just closed emphasises the importance of making this annual inventory of water power resources in order that accurate information as to the availability and use of this great national asset may be available.

A conservative estimate of the available water power of Canada, based only upon investigation of power sites at which the actual head possible of concentration is definitely established, gives totals of 18,255,000 h.p. for conditions of ordinary minimum flow, and 32,076,000 h.p. under a flow dependable for at least six months of the year. As a matter of fact, experience has demonstrated that an average machine installation is possible 30 per cent greater than that indicated by the six-month flow maximum power. Therefore it may be taken that the recorded water power resources of the Dominion will permit of a turbine installation of 41,700,000 h.p.

With the installation during the year 1924 of new wheels aggregating over 300,000 h.p., there is now installed for all purposes a total of 3,569,275 h.p., and by the completion of plants at present under construction this figure will be increased by over 600,000 h.p. before the end of 1925. Outstanding features of the developments under way or recently completed are their magnitude, the fact that they are not confined to any particular section of the country, but extend from coast to coast, and the large proportion of the power being installed which will be available for public use through the medium of central electric station organisations. There are at present 291 hydroelectric central stations throughout the Dominion, with a total turbine installation of

2,696,997 h.p. Of these, 208 stations are owned by commercial organisations, and 83 are under municipal control.

Perhaps the most conspicuous feature of recent industrial progress in Canada has been the growth of the pulp and paper industry, due to the occurrence of tremendous supplies of growing pulp wood in close proximity to readily developable water powers of a size to provide the large amounts of power essential to the conversion of the raw material into the finished product. The importance of ample supplies of low priced power lies in the fact that practically 100 h.p. is needed per ton of daily output of newsprint. A recent development of interest affecting the power consumption of this industry is the rapid adoption of electric steam boilers as a means of transforming any surplus of electric energy into steam for pulp cooking, drying, heating, etc. There are 122 pulp and paper mills operating in Canada by hydraulic or hydroelectric power, utilising a total of 731,794 h.p. This is made up of 503,039 h.p. installed by the mills themselves and 228,755 h.p. purchased from hydroelectric central stations. The rapid development of the electric drive in this industry is indicated by the fact that 215,472 h.p. of the installation in the mills is connected to generators, which added to the 228,755 h.p. purchased gives a total electric drive of 444,227 h.p., or over 60 per cent of the power used.

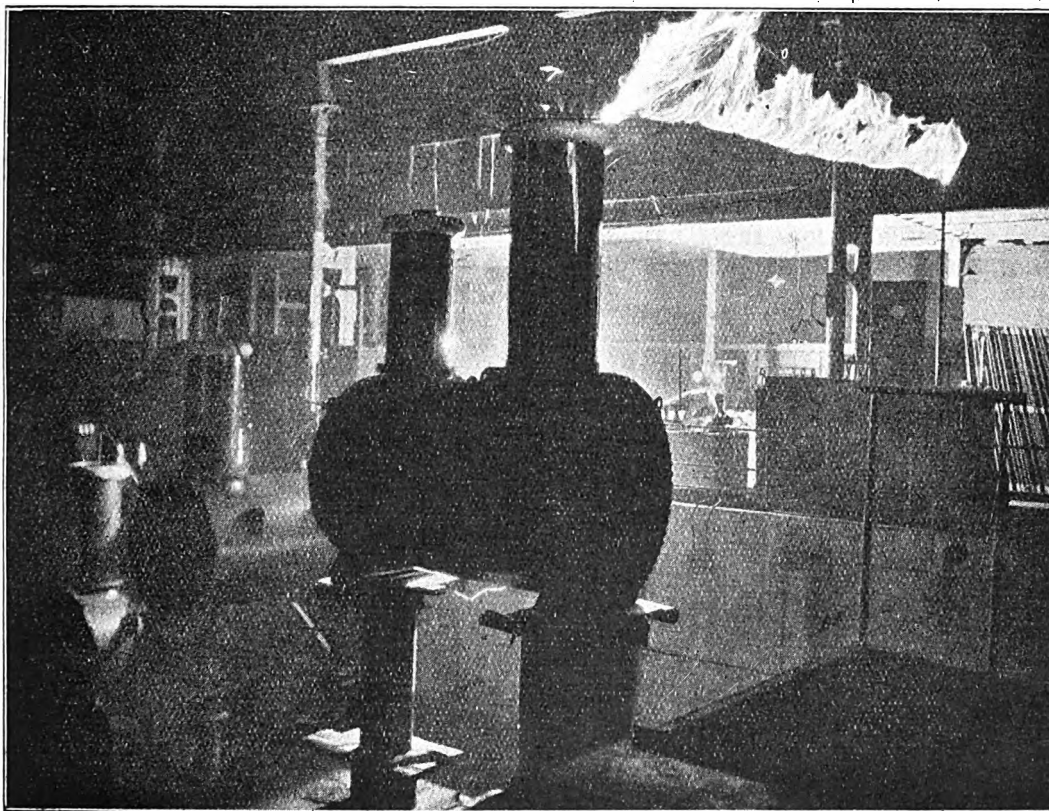
Industries other than central stations and paper and pulp mills have installed a total of 369,239 h.p. derived from water. The total installation for the Dominion is 386 h.p. per thousand of population, which figure places Canada among the leading countries of the world in per capita utilisation of water power. More detailed information is contained in the bulletin, copies of which may be obtained free of charge on application to the director of water power and reclamation, Ottawa, Canada.

Electrically operated automatic three color light signals have been installed on the railway between Auckland and Penrose, N.Z.

A One-Million Volt Arc

Research work on the phenomena attendant upon the generation and transmission of power at super-tension voltages has been engaging the attention of some of the leading electrical manufacturers for some time. This has been particularly apparent in America, owing to the demand for ever-increasing voltages in practical applications. But some of the British manufacturers are now turning their attention to work of this

former, seen at the extreme left, was supplied with energy at 6,600 volts 60 cycles and gave 333,000 volts on its secondary. The second transformer was insulated from earth and one end of its primary winding connected to the 333,000 volt terminal of the first transformer. The other end of the primary was connected to a 321,000 volt tapping, and thus the secondary of the second transformer was raised to 666,000



A 1,000,000 Volt Arc

nature, for although British practice does not make use of extra high tensions, it is nevertheless essential that full information be obtainable on the design of high tension equipment for the purposes of overseas trade. In this connection, Messrs. Ferranti Ltd. have recently been carrying out some experiments which culminated in the attainment, for the first time in Great Britain, of a pressure of 1,000,000 volts (rms.) above earth.

The voltage was obtained by using three pressure transformers connected in cascade, under the Dessauer patent, of which Messrs. Ferranti are the sole licensees for the greater part of the British Empire. The arrangement is shown in the illustration. The primary of the first trans-

former, seen in the centre of the illustration, was similarly insulated from earth and supplied from the second transformer, and the pressure was thus raised to 1,000,000 volts above earth. All these pressures are rms. values, so that the actual peak potential was 1,400,000 volts.

A sustained arc 9 ft. 6 in. in length was obtained between the secondary terminal of the third transformer and an earthing point connected through a limiting resistance. The value of the pressure was calculated from the voltage ratios of the transformers and checked by the length of the spark gap, which was adjusted according to the humidity of the atmosphere at the time. Some curious effects were observed in

connection with the experiment. The illustration shows an arc underneath the third transformer. This is due to the transformer not being far enough from the side of the testing pit, the arc jumping from the metal sheet on which the transformer stood to the side of the pit. A glow is also noticeable behind the transformer. This resulted from a short circuit which occurred in a lamp holder fixed on a pillar in the building, through high pressure being induced in the wiring.

Messrs. Ferranti have made many testing transformers during the past few years apart from those used in this experiment. These include one which gives a pressure of 500,000 volts above earth in a single unit.

NEW BRITISH POWER STATION

The recently opened Barking power station of the County of London Electric Supply Co. represents the very latest British practice. The station, which is situated on the Thames at Creekmouth, was designed by Messrs. Merz and McLellan, consulting engineers. The site has an area of 100 acres with a river frontage of 2,100 ft., and unlimited supplies of condensing water, and is capable of accommodating a power station of some 600,000 kw. capacity, divided into three sections of 200,000 kw. each. The first half section is now near completion, and considerable expenditure has been incurred in advance and in anticipation of the next extension up to 200,000 kw.

The buildings consist of the engine and boiler houses set at right angles to each other, and the switch house, control room and general offices, contained in one block set parallel to the engine house. The jetty and river works will allow at the present time ocean-going steamers of 3,000 tons to draw alongside, and ultimately 5,000-ton vessels will be able to come in. The plant at present installed includes two 15,000-kw. and two 35,000-kw. turbo-generators, ten water tube boilers, two reheater boilers, deep water jetty, with coal discharging cranes and conveyors, step-up transformers and remote controlled electrically operated switchgear. The boiler-house is under the special control of a combustion engineer, so as to ensure the highest possible efficiency and the lowest operating costs, and to assist in this the station is equipped with a chemical laboratory under a qualified expert. The coaling and ash-handling arrangements are completely automatic, and coal can be discharged either direct from the steamers into the boiler-house bunkers or temporarily stored between the jetty and the power house. In addition to river facilities the Midland railway runs through the property, with sidings connected directly with the coal storage.

The transmission lines connecting up the Barking power-house with the London area, consist

of 33,000-volt underground mains laid to three new substations, and through these connecting up with the existing stations and substations. The contracts were placed on exceptionally favorable terms, probably the lowest since the war, with the result that the capital cost per kw. of the power-house is below that of any other station of comparable size erected since the war. —(Electrical Review.)

MELBOURNE AND METROPOLITAN TRAMWAYS BOARD

The rather belated report of the chairman of the Melbourne tramways board, Mr. A. Cameron, on his trip abroad in 1923, has recently come to hand. Mr. Cameron investigated several tramway undertakings in America and Europe, principally with a view to collecting data on the operation of electric trams on the conduit system. This system had been suggested as most suitable for the conversion of the Melbourne tramways from cable to electric traction. There are only two cities in America that have conduit systems, viz., New York and Washington. In each case experience has proved that the system is difficult to maintain in good running order and is much more liable to interruption than a trolley system. The first cost is very high and operating expenses are high, indeed, it is stated that several of the companies operating these lines were totally unable to pay their way in spite of the fact that the volume of traffic was greater than the trams could carry. This was due to the limitation of fares to a five-cent maximum. It was not the conduit systems alone, however, that were in difficulties, for many trolley car undertakings also were in the hands of receivers, due to the increase of operating costs over revenue. At the same time the consensus of opinion in the United States was against the conduit system.

In Great Britain the London county council is the principal operator of conduit cars. Here a thoroughly reliable service has been established, though at considerable cost. The traffic manager considers that, with an experienced and capable staff, tramways can be operated on the conduit system with great efficiency, but the cost of installation will be never less than twice that for a trolley system. At Bournemouth and Blackpool conduit systems have been superseded by trolley cars. In Paris, where a conduit system was adopted on the grounds of aesthetic considerations, such as would influence Melbourne, the chief engineer states that the cost of the system is out of proportion to its value even with the dense population of the French capital. From an engineering point of view he does not recommend its adoption under any conditions.

Newcastle Electric Supply

In 15 years the output of the Newcastle city council electric supply department has grown from 877,600 units to 23,400,708 units. Although the council still operates its own plant, the bulk of the energy is purchased from the railway commissioners' station. In addition to supplying the city area, the council supplies 13 other municipalities. The appended table gives statistics for the last three years.

In his report covering the year 1924, Mr. Guy Allbut, engineer and manager, states that after paying all charges, and allocating an amount as a nucleus of a reserve fund, the net surplus was £11,075. The total revenue was £157,874, as compared with £129,007 for the previous year, and the gross profit £27,392, as compared with £18,976. The number of consumers increased by 2,813, making the number connected at the end of the year, 12,835.

Mr. Allbut compares the conditions ruling at Newcastle with other places, in the following terms:—

"The enquiries made abroad by me during the year have enabled first-hand comparisons to be carried out as to the results obtained in this undertaking when put alongside many of the principal undertakings of the world, and I find that there is no need to apologise for any feature of the council's activities in the matter of electric supply. Complete information has been obtained through the courtesy of many council and private electric supply undertakings which is now gratefully acknowledged, particularly in relation to the rates chargeable for electricity, and, as my reports disclose, the manufacturers and the general public in this district have, in the past, received their supply at rates which concerns, with an output eight and ten times greater, have not yet got down to. The remarkable performance of adhering to pre-war rates, which, since the close of 1924, have been reduced, I found could not be equalled in many places; and it needs to be recorded, in the plainest possible terms, that the extravagant claims as to cheap electricity in other parts of this continent and in the rest of the world where energy is obtained by the generation of electricity in steam turbines using black coal as a heat source, cannot be justified anywhere."

	Statistics		
	1922	1923	1924
Units generated ..	16,580,313	20,647,773	23,400,708
Total sold—all purposes ..	14,719,537	18,949,497	21,568,213
Quantity used in works ..	192,944	87,346	65,176
Total quantity accounted for ..	14,912,481	19,036,843	21,633,389
Loss in Distribution, etc. ..	1,667,832	1,610,930	1,767,319
Kv.a. capacity of generating and transforming plant	3,987	4,187	4,987

	1922	1923	1924
Maximum simultaneous load in kw.	4,384	5,070	7,536
Connections in Kw.	14,516	16,521	19,329
Units sold per kw. connected	1,014	1,147	1,115
Kv.a. capacity of distrib. transformers	3,320	4,565	3,960
Works cost per unit sold	.958	.875	.885
Total cost per unit sold	1.44	1.32	1.365
Average receipt per unit sold	1.61	1.63	1.55
Street Lighting, City—Incandescent lamps	638	648	678
Units sold	333,081	353,144	392,466
Av. receipt per unit—pence	3.60	3.73	3.29
Private supply—			
60 watt lamp connections	73,529	88,522	109,274
H.P. motors connected	9,131	9,652	10,322
Heating conn. kw.	3,175	3,871	5,073
Units sold—light	2,504,009	3,087,444	3,923,878
Unit receipt for light	3.85	3.84	3.869
Units sold—power	11,882,447	15,508,909	17,251,869
Unit receipt for power	1.08	1.01	1.029
Motors on hire	188	214	220
No. of private motors maintained	50	50	70

CENTRAL POWER BOARD, N.Z.

The report on the operations of the central power board, the headquarters of which are at Hamilton, for the year ended March 31, 1925, shows that satisfactory progress has been made towards bringing the supply undertaking to a successful issue. It is now four years since the construction work was commenced, and several extensions not considered in the original plan have been made. The total number of consumers is now 2,204, and the connections are as follow:—Lighting, 2,129; heating, 383; milking machine motors, 534; other motors, 86; water heaters, 272; water pump motors, 78; electric ranges, 32. There has been a steady increase in the demand for energy for heating and cooking purposes, largely brought about by the reasonable charge (1½d. per unit) for these services. During the year the board took over the supply plant and reticulation of the town of Huntly, and two new areas were added to the board's district. The whole of the loan of £200,000 has been raised and approval has been given for the raising of an additional 10 per cent should it be required. The revenue for the year under review amounted to £23,374, and the credit balance is £9,030. The extent of this balance is chiefly due to the fact that interest and sinking fund, amounting to £8,200, was paid out of loan account. Also provision has not yet been made for an adequate depreciation and renewal fund.

Launceston Electricity Supply and Tramways

The report of the Launceston, Tas., municipal electricity supply and tramways for the year ended June 30, 1924, is to hand from Mr. R. J. Strike, city electrical engineer and superintendent of tramways.

Electricity Supply

The increase in connections to the mains totalled 1,906 kw. The peak load for the year was 2,363 kw. of which the council's hydro station was responsible for 1,249 kw., the balance (1,114 kw.) being supplied by the government hydroelectric department. The contract with the government is for 3,000 h.p.

The supply to the consumers is being changed over from 110/190 to 240/415 volts.

FINANCIAL POSITION

	1923-4
Amount of loans sanctioned	£ 280,000
Amount borrowed	222,715
Amount expended	255,463
Amount of sinking funds	71,185
Amount of reserve funds	28,233
FINANCIAL RESULTS	
Completed year of working	28th
Revenue from lighting rate, net	£ 5,033
Street lighting	4,389
Electricity supply, net	35,080
Rentals, meters, motors, etc.	3,454
Trading and other sources, net	7,264
Revenue, total from all sources, net	55,220
Total costs, less discounts, etc.	40,129
Gross profit	15,091
Interest on loans	13,396
Sinking fund contribution	2,252
Percentage of gross profit to capital ..	6.78%
Financial result—Deficit	557

SUPPLY RECORDS

Kilowatts connected at end of year	10,025
Units generated—	
Hydraulic	2,347,850
Steam	Nil
Purchased	3,977,000
	6,324,850
Units sold—	
Private supply	3,279,294
Street lighting	366,526
Tramways	1,190,256
	4,836,076
Maximum load reached	2,363 kw.
Load factor	30.57
Capacity of plant at end of year—	
Hydraulic	1,950 kw.
Steam	337 "
Bulk supply	2,238 "
	4,525 kw.

Population	28,000
Maximum demand per head	84.38 watts
Units generated per head	223
Average price received per unit sold—	
Private supply	2.341d.
Street lighting	2.874d.
Tramways	0.625d.
Total supply averaged	1.959d.

LIGHTING—

Number of consumers at 30th June	5,693
Equivalent 30-watt lamps connected	83,796

POWER (including tramways)—

Number of motors in use at 30th June ..	903
Total aggregate b.h.p. connected	6,120

HEATING, etc.—

Number of heaters, etc., in use at 30th June	2,040
Total aggregate kw. connected	2,062

Prices Charged

Private Lighting—

6d. per unit for first 5 units used per 30-watt lamp per quarter.

3d. per unit thereafter.

Private lamps in streets and verandah lights, half rates.

Power and Heating—

2d. per unit for first 200 units per b.h.p. or kw. per quarter.

½d. per unit thereafter.

Heating only, 1d. per unit. Minimum, 90 units per quarter.

Continuous hot-water systems, ½d. per unit. Minimum, 730 units per quarter.

Power, sliding scale—0.870d. for a total of 10,000 units, down to 0.6d. for 50,000 units per quarter.

Special contracts for powers above 80 kw. demand.

Electric Tramways

The track mileage was not increased during the year, but equipment was purchased for the extension of the Newstead route to Killafaddy.

FINANCIAL POSITION

	1923-24
Amount of borrowing powers	£ 175,000
Amount borrowed	150,414
Amount expended	134,484
Amount of sinking fund	17,274
Amount of reserve fund	16,991

FINANCIAL RESULTS

Year of working	13th
Revenue—	£
Traffic	44,391
Rates (less discount)	10,065
Other sources	168
Total, net	54,624
Total Costs	36,919
Gross profit	17,705
Interest on loans	8,471
Sinking fund contribution	1,503
Financial result—Surplus	7,731

ANALYSIS OF EXPENDITURE

Item	£	Per car hour shillings	Per car mile pence
Traffic expenses	20,392	6.239	10.352
General expenses	4,552	1.393	2.311
Repairs and maintenance	8,875	2.716	4.506
Power, expenses	3,100	0.948	1.573
Interest and sinking fund	9,974	3.052	5.063
Totals	£46,893	14.348sh.	23.805d.

STATISTICAL INFORMATION

Population served by tramways	18,000
Population served per street mile	1,757
Passengers carried	4,540,999
Car miles run	472,701
Car hours	65,362
Mileage of track—	
Single track	5.912
Double track	4.563
Total as single track	15.039
Street miles	10.247
Average traffic revenue—	
Per car mile	22 53d.
Per car hour	13.58 sh.
Per street mile	£4 29d
Per passenger	2.343d.
Number of passengers per car mile	9.528
Average working expenses per car mile	19.513d.
Average working expenses per car hour	11.296 sh.
Average journeys per head of population served	252
Total number of cars in stock	25
Units used, high tension	1,190,256
Units used per car mile	2.517
Units used, d.c. to trolley wires	859,610
Units used, d.c. to trolley wires per car mile	1.818

Radio News

Mr. G. Shrimpton, of Wellington, N.Z., was recently able to get into two-way communication with a Swedish station, SMYY, and an Italian amateur, 1RG, on the same evening.

A regular news service for ships at sea in the vicinity of the Australian coasts has been commenced. The messages are being compiled by the prime minister's department and are transmitted gratis by Amalgamated Wireless Ltd. The Perth transmitting station operates on 1,800 metres, that at Darwin on 600 metres, and the Sydney station on 2,100 metres.

A $\frac{1}{2}$ -kw. wireless telephony set, recently supplied by Amalgamated Wireless (Australasia) Limited to the British Phosphate Commission at Nauru, is giving exceptionally good results. Tests between the set and the radio station at Bita Paka (Rabaul), a distance of nearly 900 miles, have resulted in good speech both ways during daylight.

The Trades and Labor Council, New South Wales, has decided to proceed with the erection of a radio broadcasting station of 2,000 to 3,000 watts. The purposes for which it is to be used are:—Communication between union centres and branches, between union offices and organisers in the field, and between interstate offices; parliamentary election propaganda; working-class education; strikes; arbitration matters.

During the course of a lecture delivered recently in Sydney, Mr. E. T. Fisk stated that there was a possibility of 2FC erecting a powerful new broadcasting station in the vicinity of the Pennant Hills commercial wireless station.

He stated that the present tendency was to increase the power of transmitting stations, so that all parts of the country should soon be within fairly easy reach of broadcast services.

With a view to minimising liability to interference, readjustments are being made in the wave lengths of certain of the Australian broadcasting stations. 2BL, Sydney, will operate on 353 instead of 350 metres; 3LO, Melbourne, is reducing to 371 metres; 5CL, Adelaide, has been allotted 395 instead of 375 metres; 7ZL, Hobart, is rising from 410 to 417 metres; and 3AR, Melbourne, is to use 484 instead of 480 metres. All these stations, with the exception of that at Hobart will be operating on a power of 5 kw. when the arrangements are complete.

NEW BRITISH BROADCASTING STATION

In view of the alterations and new construction now being carried out in connection with several of the Australian broadcasting stations, it is interesting to note that the British Broadcasting Co. has constructed an entirely new station to take the place of the pioneer broadcasting station, 2LO. "Electricity" states that this new station will be one of the finest of its kind in the world. The apparatus has been designed, constructed and installed by the engineers of the Marconi Co., and is built on exactly the same lines as the company's type Q stations, except that it is twice as powerful.

The official rating of the station is 3 kw., but this indicates the power radiated from the aerial. In arriving at the total power absorbed by the apparatus, allowance must be made for the modulator circuits, which are designed with generous proportions to avoid any possible distortion which would be introduced if they were pressed to the limits of their capacity. There is also the power to the independent drive circuits or master oscillators, and power consumed by the filaments of the various oscillating, modulating and rectifying valves, as well as the ordinary losses of power in the motors, generators, transformers and other associated circuits. In all, 18 kw. is delivered from the mains and some 12 kw. is supplied to the apparatus during a broadcasting programme.

The apparatus is installed in three separate rooms. One contains the main transmitting apparatus, comprising the independent drive, units, the power magnifier units, the modulation units and their associated h.f. tuning circuits. Another contains all the running machinery, including duplicate motor alternators which deliver a power of 12 kw. to the transmitter, the battery charging generators and the switchgear controlling the machinery. The third room contains all the accumulator batteries, which supply the current to the filaments of the modulator valves

in order to prevent any possibility of the characteristic hum of the alternators having any effect on the carrier wave.

Apart from the greatly increased power obtained from this equipment compared with that of the older equipment, the range of the station will be still further increased by the use of a larger aerial supported at a greater height than it was possible to use at the old station at Marconi House, where the structure of the building would not permit of the erection of high towers. The building on which the new station is erected has more solid foundations and sufficient strength to permit of the erection of two towers, each 125 ft. high, instead of the 50-ft. masts installed on the roof of Marconi House. This improvement alone, without making any allowance for the increased power, will more than double the range of the station.

The studio, which has always been entirely distinct from the transmitting apparatus, will remain at the B.B.C. headquarters at Savoy Hill, and will be connected to the transmitter, as before, by special underground cables.

RADIO EXHIBITION IN MELBOURNE

A radio exhibition, organised by the Victorian division of the Wireless Institute of Australia, was held in Melbourne from May 20 to May 30 inclusive. The objects of the display were to give publicity to the latest developments in wireless apparatus for popular use and to raise funds for the equipment of the Institute's experimental station now under construction. The opening was performed by the postmaster-general, who spoke in a small room adjacent to the main hall, and whose voice was broadcast through the building by means of a Western Electric public announcing system. During the course of the exhibition several lectures on topics of interest to radio enthusiasts were given in a similar manner.

The various stalls exhibited a comprehensive display covering everything of interest to the listener-in and experimenter. Amongst the complete sets may be mentioned the Radiola Super, displayed by Louis Coen, which has sufficient amplifying power to be able to dispense with aerial, earth and external loop. A. Beal Pritchett exhibited a very efficient combination in the Begolian Special Two, a two-valve reflex set. Messrs. Corbett, Derham and Co. have apparently reduced costs to the minimum in being able to offer the Tunafone Complete Three, a three-valve receiver with loud speaker, for £30. Amongst accessories and parts there was such an extensive display that it was difficult to pick out any of outstanding merit. Messrs. Phillips had an impressive exhibit of valves of all types and sizes; Siemens Bros. were showing amongst other articles the Sack Leclanche cell for

filament supply, for which high efficiency and long life are claimed; the trend of development towards obtaining greater purity of tone in loud speakers was shown in the new types of cone and pleated disc sound magnifiers exhibited on several stands. Messrs. Osboldstone and Co. Pty. Ltd. had a fine display of McMichael sets and parts including home-assembly receivers and several new and interesting accessories. These parts are of British manufacture and are of first-class quality.

A special section of the exhibition was set apart for displaying the work of amateur constructors. Many intricate panels were to be seen in this section, some giving evidence of great skill and care in construction and showing fine workmanship. Prizes were given for the best exhibits in various classes, but the awards were based only upon the appearance of the sets and not on performance. In many cases in radio work it happens that the apparatus which gives the best practical results is far from being the most pleasing to the eye, so the value of prizes given on appearance only is not very great. Perhaps the most interesting exhibits were the transmitting and receiving sets of Messrs. Max Howden, Ross Hull, and E. H. Cox, the well-known amateurs who have done such fine long distance work.

Telephony and Telegraphy

COMMONWEALTH P.M.G.'s DEPARTMENT Operations during May

New South Wales.—Six new trunk circuits have been completed, thirteen country public lines erected, and several miles of cable, ranging up to 800 pair, laid. New sections of the Sydney to Ingleburn and Sydney to Bathurst trunk circuits were completed, and the Goulburn section of the Sydney to Canberra telegraph circuit completed. Eight new exchanges have been opened, and additional equipment installed at 16 country centres.

In connection with the establishment of the new automatic exchange at City East (Sydney) the bulk of the automatic switchboard equipment has been delivered and the installation thereof commenced. This exchange when opened will provide for 4,700 subscribers, with an ultimate capacity of 10,000 subscribers, and will replace the existing manual exchanges at William street and Paddington.

Victoria.—Six trunk circuits have been completed and six country public lines erected. About 15 miles of cable, ranging up to 600 pair, has been laid. Sixteen new country exchanges have

been opened, new switchboards fitted at 11 offices, and additional equipment erected in 20 country centres.

Queensland.—Nine new exchanges have been opened, and additional equipment installed at six centres.

An automatic telephone exchange has been opened at South Brisbane.

South Australia.—Three new sections of trunk telephone circuit and one new telegraph circuit have been completed. Also an additional country public line has been erected. Twelve miles of cable, ranging up to 800 pair, has been laid. Additional exchange equipment has been installed at 14 country centres.

Western Australia.—Two additional trunk circuit sections have been completed; also eight country public lines and an additional telegraph circuit. New exchanges have been opened at 17 centres, and additional equipment installed at three offices.

Tasmania.—Two trunk circuits have been completed and new exchanges opened at six centres.

owing to the small development of overhead transmission in England, foreign data, particularly concerning American lines, has been drawn upon. The final chapters deal with constructional methods, and it is interesting to note a description of the erection of the Yallourn-Melbourne 132,000 volt line in this connection.

Industrial Electricity.—By W. H. Timbie. Chapman and Hall Ltd., London. Pp. 721. Price in Australia, 22/-.

The purpose of this book is to explain how direct current electricity is generated, transmitted and used, and to afford an adequate foundation for further study in the application of alternating current energy to modern practice. It deals with elementary considerations in d.c. electricity, and with magnetism and magnetic circuits, and goes on to the theory and characteristics of d.c. motors and generators. The final chapters deal with a multiplicity of subjects, including inductance, dielectrics, condensers, electrochemistry, electrical measuring instruments, and vacuum tubes. The text includes a great deal of purely descriptive matter and each chapter contains a number of problems bearing on the subject dealt with. A booklet of answers to the problems is supplied at a cost of 3/6. The name of the volume is hardly an indication of its character, for it is no more than a text book of elementary direct current electrical engineering.

Junior Technical Electricity.—By Robert W. Hutchinson. University Tutorial Press, London. Pp. 371. Price in Australia, 6/-.

Mr. Hutchinson is well known as the author of several text books dealing principally with electricity and magnetism. This latest addition to his works is issued as a first year course in electrical engineering for students at technical schools and universities, and its main object is to give a clear insight into the fundamentals of electrical theory. The book combines scientific principles with engineering practice, starting from the very beginning and building up the theory on experiment and observation. Amongst the subjects dealt with are magnetic theory, applications and measurements; electrostatic theory; the fundamentals of current electricity, primary cells and accumulators; the elements of dynamo-electric machines; measuring instruments; wiring, and telegraphs. Each section is dealt with in an elementary way and in a manner to lay the foundation for more extensive studies. The explanations are clear and the text is illustrated with numerous diagrams.

History of the Telephone in the United Kingdom.—By F. G. C. Baldwin, M.I.E.E. Publishers, Chapman and Hall Ltd., London. 725 pp. Price in Australia, 50/-.

It was only in 1912 that the British government acquired the telephone systems, and coor-

New Publications

Elements of Electrical Engineering.—By A. L. Cook. Chapman and Hall Ltd., London. Pp. 554. Price in Australia, 25/-.

This new addition to the numerous text books of electrical engineering commences with the assumption that the student has a knowledge of elementary electricity and magnetism, thus it does not attempt to cover a universal range. Its field is confined to those subjects most commonly needed by the average electrical engineer. It is divided into four sections. The first deals in a general way with electrical and magnetic circuits; the second with direct current machinery, describing the general theories of design and operation; the third describes the principles of alternating currents; and the fourth deals with a.c. applications such as transformers, motors of various types, etc. The volume should provide a good groundwork on which to build further studies into special electrical problems.

Mechanical Design of Overhead Electrical Transmission Lines.—By Edgar T. Painton. Chapman and Hall Ltd., London. Pp. 269. Illus. Price in Australia, 20/-.

This book is written primarily for the use of the consulting engineer and designer of overhead transmission lines and deals in a comprehensive manner with the various problems which require solution on the mechanical side of line construction. The greater portion is devoted to theoretical considerations in the designing of conductors and supports for lines of many different types. There is a great deal of matter descriptive of present day practice, in which,

minated the services of the National Telephone Co., the post office, and the municipalities that had established exchanges. There is still one municipal telephone service in the United Kingdom, viz., that at Hull.

The volume traces the development of the telephone from the time of its invention by Graham Bell. The first telephones were demonstrated in the year 1877 at the Liverpool meeting of British association, Bell having taken out his first British patent in December of the previous year. It is significant that the experts of the British post office at that time reported "that the possible use of the telephone was very limited." The first telephone company in Great Britain was registered in June, 1878, and the early instruments were imported from the Bell Telephone Co. of America. The idea of a telephone exchange was also imported from America, and the first exchange in London was opened in August, 1879, with seven or eight subscribers. Thereafter progress was rapid. On the ground that a conversation through a telephone was an infringement of the telegraph acts, the United Telephone Co. was compelled in 1880 to take out a license from the government and pay 10 per cent of gross receipts to the post office.

The author has taken a considerable amount of trouble to trace the development of the technical side of the system, and telephone engineers will be very interested in the information and illustrations regarding the various types of apparatus in use. It is gratifying to know that a fairly complete range of this early apparatus has been preserved and is housed in the South Kensington museum and in the museum of the Institution of Engineers.

The book is copiously illustrated and altogether well produced.

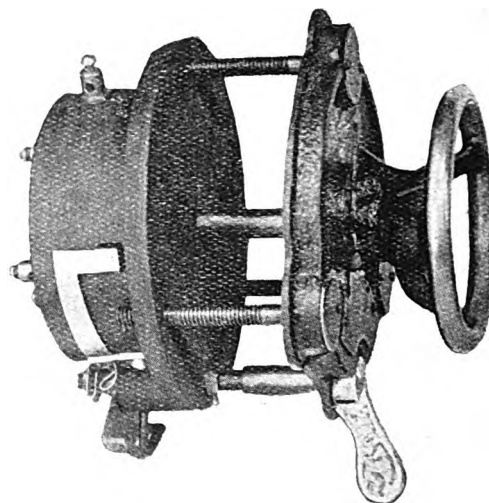
Trade Notes

Removal Notice.—The Melbourne branch of the Lawrence and Hanson Electric Co. Ltd. has moved to premises at 172 William street, which were formerly occupied by Messrs. Homewood and O'Neill Pty. Ltd.

O. J. Nilsen and Co., electrical engineers, of Melbourne, have opened a branch in Adelaide, trading as an electrical and radio supply house and as electrical contractors. The sales department and office is situated at 35 King William street.

Electrical Accessories and Engineering Co. of Australia Ltd., with authorised capital of £15,000, has been formed for the purpose of acquiring from W. E. Grant and M. B. Bean the rights and interests in the "Agrippa Electric Holder," and to carry on business as electrical engineers. The first directors are: M. B. Bean, R. H. K. Wood, and D. Wentworth, and the registered office is at Cathcart House, 15 Castlereagh street, Sydney.

The F/M Switch.—The Electricity Meter Manufacturing Co., Sydney, is manufacturing a new type of multiple position switch which should prove useful on switchboards in place of the present plugs and switches for taking



The F/M Voltmeter Switch

several voltage or current readings on one instrument. The illustration shows it to be neat and compact and easily mounted. It is operated by a small hand wheel and its position is indicated by a pointer on the moulded faceplate.

Berkery-Picken (Electric) Pty. Ltd., electrical contractors and radio engineers, Melbourne, are in liquidation. The failure of the company is said to be due to unanticipated high overhead costs. Representatives of Noyes Bros. (Melb.) Pty. Ltd., Johnson and Phillips Pty. Ltd., and the Australian General Electric Co. Ltd. have been appointed an advisory board to act in the interests of the creditors, and tenders have been called for the purchase of the company's stock.

Electric Wash Boiler.—Messrs. H. Rowe and Co. are introducing a new domestic electrical line in the Jackson electric wash boiler. It is a very simple and neatly designed piece of equipment, holds 10 gallons of water, and is rated at 3 kw. It may be obtained with either a galvanised steel or a copper body, the latter being the higher in price. The element consists of a spiral of resistance wire wound on a fire-clay former and enclosed in a solid drawn metal tube welded or brazed into a sump in the bottom of the boiler. The tube is placed so that its barrel is entirely surrounded by water, thus gaining a high efficiency. Boiling a copper full of water with energy at 2½d. per unit costs 6d. This may appear expensive, but when it is considered that this boil is usually only required once a week the real economy becomes more apparent. The price of the unit with copper body is £14/17/6.

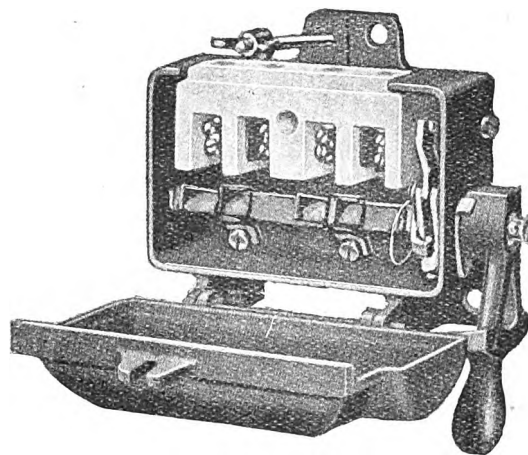
Messrs. Gibson Battle (Melb.) Pty. Ltd. advise that their principals, Messrs. Brown Boveri, of Switzerland, have recently received orders for several large mercury arc rectifier installations in Europe and America. These include 15 complete substation equipments, each supplying 1,000 kw. at 1,500 volts, for the Dutch railways, four complete substation equipments, each supplying 1,500 kw. at 1,500 volts for the Illinois railway electrification, and two rectifier sets, each of 1,000 kw. capacity at 460 volts, for the Ford Motor Co. of Detroit.

Power Factor Correction.—The Electric Construction Co. Ltd., of Wolverhampton, England, is manufacturing two types of motor that will enable power users to take advantage of the power factor clauses which are inserted in most bulk supply tariffs. The E.C.C. synchronous motor follows along conventional designs and, in common with others of its type, is limited in application to drives that allow of starting under light load. It starts as a squirrel cage motor, giving a torque of about 45 per cent of that at full speed, and taking about double full load current. The starting and control gear includes a main oil switch with overload and no-volt releases, a non-automatic change-over oil switch for use with an auto transformer which limits the applied voltage at starting, a field-break switch, and an exciter regulator. The starting operation is simple and the machine is self-synchronising. The other type of motor is designed to cover the field which the synchronous motor cannot handle, i.e., it gives full power factor correction, while being capable of starting under full load. It consists of a slip-ring motor with a d.c. exciter. The latter is connected permanently in one of the phases of the rotor circuit. After being started by means of a three-phase starter in exactly the same manner as a slip-ring motor, the machine automatically pulls into synchronism on reaching top speed. The starting gear includes a main oil switch with overload and no-volt releases, an ironclad oil-immersed rotor starter interlocked with the oil switch, an exciter regulator, and a two-way switch for cutting out one phase of the starter when the motor is up to speed. The synchronous-induction motor, like the synchronous motor, may be designed to run at any desired power factor. The standard machine is usually arranged to give .9 power factor leading at full load. At lower loads the power factor leads still more. By reducing the exciting current, however, unity power factor can be obtained at all loads. The standard synchronous-induction motor is designed to give a starting torque equal to full-load running torque, taking not more than 1.25 times full-load current. For special requirements it may be designed for starting at 1.25 times full-load torque, taking 1.7 times full current. The

efficiency of the machine is the same as that of the ordinary induction motor.

Further information regarding these useful machines may be obtained from Messrs. Lascelles Parrington Ltd., Melbourne, Australian representatives of the Electric Construction Co. Ltd., or from their interstate and N.Z. agents.

The Memette Ironclad Switch. — M.E.M. switches, the product of the Midland Electric Manufacturing Co. Ltd., England, are noted for robustness of construction and general reliability. The firm manufactures a full range of low tension ironclad switch and fuse gear, the latest addition to its products being the Memette switch which has many commendable features.



Memette Ironclad Switch

It is a double pole switch rated at 15 amps and is made up in two forms, with or without fuses. The fuses are of the Kantark pattern, porcelain thumb type, with solid brass self-aligning contacts, and are connected to the switch by solid brass bar. The illustration shows the Memette switch without fuses. Its most striking characteristic is its compactness; the overall dimensions are $3\frac{3}{4}$ in. x $4\frac{1}{4}$ in. x $2\frac{1}{4}$ in. It is ruggedly constructed and is equipped with quick make and break action, so that it cannot be inched in or left in partial contact. These features make it particularly suitable for house service work or in any situation where non-skilled operation is likely. The switch case is of fine grey cast iron, enamelled black, and is particularly neat and attractive. The blades are of hard drawn copper mounted on a square steel shaft insulated with bakelite tubing. The clearances between live metal parts are ample, and the heavy porcelain base acts as an effective damper to any arc which might form. Tests on a standard switch under exceptional service conditions have shown remarkable results. The switch was connected to a 250 volt circuit, with the same voltage between live metal and case, and operated about 200 times at currents rising from 15 to 200 amps. It successfully broke 200 amps. at 250 volts,

representing an overload of 1,330 per cent. Equally satisfactory breaking was shown with 25 amps at 375 volts and 15 amps at 440 volts. A further test consisted in mechanically operating the switch 4,000 times at full load and voltage, after which it was left in circuit until a final temperature was reached indicating a rise of 26 deg. F. The British standard specifications allow 36 deg. F. rise. A 2,000 volt flash test revealed no fault, and an insulation test with a 500 volt megger showed infinity. A test of the fuses with a current of 45 amps. resulted in perfect clearing of the circuit. A further test by short circuiting the fuses across the terminals of a 250 volt 500 amp. hour battery gave an equally satisfactory break. A final examination proved that the switch had withstood all the tests without damage to any part. Such results give evidence of accurate design and sound workmanship and constitute a strong recommendation for the product.

The J. and P. Transformer Book.—Messrs. Johnson and Phillips, the well known electrical manufacturers, have published a valuable text and reference book entitled, "The J. and P. Transformer Book," which is described as a

practical technology of the power transformer. It is written by Messrs. S. Austen Stigant and H. Morgan Lacey, manager and chief designer respectively of the firm's transformer department. It contains 400 pages and is profusely illustrated with photographs and diagrams. The volume deals particularly with the design, construction, testing and maintenance of oil-immersed, self-cooling, core transformers up to about 2,000 kw. capacity, although there is some reference to units of different designs and capacities. It is intended to provide for the everyday requirements of practical electrical engineers, and that the field is very thoroughly covered is indicated from the titles of some of the chapters. These deal with such aspects as fundamental principles, inquiries and tenders, specifications, types and connections, testing, dispatch, installation, maintenance, parallel operation, protection, transient phenomena, causes of failure, transformer oils, etc. Theoretical considerations are blended with practical applications in such a manner as to make the book extremely valuable to all who have any dealings whatsoever with power transformers of moderate size.

Lighting and Power

Albury, N.S.W.—Aldermen Burt and Allen have resigned from the electricity committee of the municipal council as a protest against the reinstatement of a member of the electric supply staff who was suspended three months ago on the recommendation of the electrical engineer. The recent resignation of the electrical engineer was due to the lack of support given his recommendations with regard to staff matters by the committee and council.

Angaston, S.A.—The electric supply from the transmission system of the Adelaide Electric Supply Co. has been switched on. The line runs from the Osborne power station through Gawler, Freeling and Nuriootpa. Transmission is at 33,000 volts, and distribution at 400/230 volts, 50 cycle three phase. Outdoor step-down stations are used at all load points.

Ashburton, N.Z.—Rapid progress is being made with the reticulation of the Ashburton power board's scheme. The first 500 miles of pole line has already been erected and wired. It is anticipated that the final 250 miles of wiring will be completed within the next three months, and the major portion of the house reticulation finished by the end of October. The sale of fittings, especially cookers, has been unprecedented.

Auckland, N.Z.—The Waitemata power board is raising a loan of £200,000 at 5½ per cent interest, for 36½ years. The money is to be obtained in Australia.

Avoca, Vic.—Steps are being taken to form an electric supply company. Messrs. T. M'Laughlin, A. C. Summers, A. F. Kaye, F. L. Burns and J. J. M'Donald have been appointed provisional directors, and Mr. F. L. Burns secretary pro tem.

Belgrave, Vic.—The electricity commission expects to be supplying electrical energy in the district about October next. In the meantime consumers are without light

as the privately operated plant which had been giving supply was shut down last January.

Blenheim, N.Z.—The Marlborough power board's £300,000 loan proposal has been carried.

Bordertown, S.A.—The electric supply scheme was put into operation on May 13. Energy is generated by the Border Electric Supply Co. and sold in bulk to the Tatiara district council, which controls the distribution. The plant consists of a 24/28 h.p. Petter crude oil engine belt driving a 20 k.v.a. Thrige alternator. The distribution system is 415/240 volts, 50 cycle three phase a.c. The Southern Electric Power Co. was the contractor for the plant.

Busselton, W.A.—The municipal electric supply station has been destroyed by fire. The plant was suction gas driven, of a total capacity of 75 kw. In addition to the lack of lighting and power the town is without a water supply as the pumping plant was electrically driven. The damage, which is estimated at £3,250, is partially covered by insurance.

Carterton, N.Z.—The total number of consumers now connected to the mains of the Wairarapa power board is 1891. The board is considering further reticulation to the extent of 90 miles of line.

Coraki, N.S.W.—Mr. S. M. Williams, of Kempsey, was the successful applicant for the position of electrical engineer to the council's supply undertaking.

Cottesloe, W.A.—Arrangements have been completed for bringing the electric supply direct from Perth instead of through North Fremantle. This will cut out many of the interruptions which have been occurring.

Davenport, S.A.—A poll of ratepayers on the proposal of the municipal council to borrow £2,200 for electric supply purposes resulted as follows:—For the proposition, 130; against, 44.

Eketahuna, N.Z.—The Tararua power board is inviting tenders for the purchase and removal of the suction gas and generating plant at the Pahiatua and Eketahuna power stations. The board is now purchasing energy in bulk from Mangahao.

Frankston, Vic.—The electric supply, which is in the hands of the shire council, is being changed over from single phase to 400/230 volt, 50 cycle three phase. A new brick substation with provision for three 50 k.v.a. transformers has been erected. One Weymouth transformer has been installed, and the wiring is ready for a second unit. Bulk supply is received from the electricity commission at 20,000 volts. A 6,600 volt three phase line supplies the Mt. Eliza district.

Both the Frankston and the Mornington shire councils are very dissatisfied with the charges for bulk energy supply levied by the electricity commission. Owing to the floating nature of the population of these holiday resorts a maximum demand charge imposes a heavy burden on the councils' supply undertakings. In the case of Frankston it is stated that before the electricity commission gave the supply, and when there were under 100 consumers, the electric supply accounts showed a credit. Under the present conditions with 400 consumers and no reduction in retail charges the undertaking does not pay.

Gladstone, S.A.—A poll of ratepayers on a proposal for the electric lighting of the town by the Adelaide Electric Supply Co. resulted as follows:—Yes, 133; no, 6.

Greymouth, N.Z.—The Grey power board's steam power plant at Dobson will be opened towards the end of this month.

Hopetoun, Vic.—Mr. Sharp has been appointed engineer in charge of the Beulah power plant.

Invercargill, N.Z.—The Southland power board's hydroelectric development at Lake Monowai has been put into operation.

June, N.S.W.—It is stated that the bulk supply of energy from the Burrinjuck hydroelectric scheme will be made available at the municipal boundary at about 3½d. per unit. The present cost of current at the municipal generating station is about 11d. per unit.

Kadina, S.A.—The balance sheet of the municipal electric supply department for the year ended Nov. 30, 1924, has been issued. The credit balance from the previous year amounted to £4,696, and the receipts for the period under review were as follows:—Lighting, £2,886; power, £187; meter rents, £257; street lighting, £200; trading, £173; special rate, £902; sale of 75 h.p. gas producer, £152; refund of duty on 100 kw. generator, £144; miscellaneous, £139. The expenditure was as follows:—Wages, £983; fuel and battery acid, £666; trading, £127; miscellaneous, £339; alterations to mains, £63; engine replacement, £845; extensions to plant, £3,700; extensions to mains, £68; repayment of loans, £1,528; sinking fund and bank fees, £362. The credit balance at the end of the year's operations amounts to £1,058. The plant has recently been modernised by the installation of a 160 h.p. Crossley crude oil engine direct coupled to a 100 kw. E.C.C. generator, and a 52-57 h.p. Crossley crude oil engine direct coupled to a 30 kw. E.C.C. generator. In addition there is a stand-by set comprising a 100 h.p. Premier suction gas engine direct coupled to a 60 kw. E.C.C. generator, and a 500 amp. hour Tudor battery of 125 cells. Mr. H. Rhodes is the electrical engineer.

Lara, Vic.—A proposal is on foot for extending the electric supply from Geelong to Lara.

Lilydale, Vic.—The transfer of control of the shire council's electric supply undertaking to the electricity commission has been completed. Mr. T. Farr has been appointed district superintendent, with Mr. A. G. Ashley second in charge.

Mildura, Vic.—The municipal council has decided upon a systematic canvass of the town with a view to increas-

ing the consumption of electrical energy. There is also a movement on foot for supplying the town of Merbein from the Mildura plant.

Mount Dandenong, Vic.—The question of an electric supply scheme for the mount is being investigated.

Natimuk, Vic.—The Arapiles shire council is borrowing £4,000 for electric supply purposes.

Nelson, N.Z.—The city electrical engineer, Mr. C. A. Henderson, has advised the council to purchase a new 600 kw. turbo-alternator to augment the present supply.

New Plymouth, N.Z.—The report of the borough electric supply department for the year ended Mar. 31, 1925, gives the units generated as 4,838,340, units used in power house 315,600, and units lost in transmission and distribution 674,220. The plant is hydroelectric, of 2,750 kw. capacity. Mr. W. H. Huggett is electrical engineer and manager.

Palmerston North, N.Z.—The substation at Bunnythorpe, through which the Manawatu-Oroua power board receives its energy from Mangahao, has been officially opened. The offer of the board to supply Palmerston North borough council with current at the government standard rate, plus the cost of maintaining the transmission line from Bunnythorpe to Terrace End, has been accepted by the council. The power board has agreed to cooperate with the council in approaching the public works department with a view to getting the department to take over the maintenance of the line. An endeavor is also to be made to secure the ten per cent reduction from the government when supplying the board. The council's supply is to commence on July 1.

Patea, N.Z.—A new electric supply authority has been formed under the title of the South Taranaki power board.

Pukekohe, N.Z.—The Franklin power board's proposal to raise a loan of £200,000 has been carried.

Redcliffe, Q'ld.—A scheme for giving bulk supply to the district is being brought before the town council. Mr. Hindman, of the metropolitan electricity board, states that supply could be brought from Brisbane by a high tension line and the district reticulated at a total cost of about £15,500. The cost of current for lighting would not be more than 8d. per unit.

Tauranga, N.Z.—The new hydroelectric works at McLaren's Falls were recently threatened by an exceptional flood on the Omanawa river. Heavy rainstorms caused the stream to rise nearly 40 ft. in three hours. The main dam is only just finished, the last concrete being placed three days before the flood but, in spite of the weight of water behind it, it stood without injury of any kind.

Wanganui, N.Z.—The mayor states that the borough council is saving about £8,000 a year through having disposed of its steam power plant and taking supplies from the Wanganui-Rangitikei power board.

Wangaratta, Vic.—The borough council has been supplied with energy in bulk from the Wangaratta Woollen Mills Co. at 3d. per unit, but the company has found that the generation costs, without allowing for depreciation on the machinery, amount to 3½d. per unit. The principal reason for this state of affairs is that the current consumption is considerably less than was originally estimated. The council has been making a profit from the sale of current, which amounted to £600 last year, and is estimated at £1,050 for the current year. At the request of the Woollen Mills Co. a readjustment has been made whereby the council will be charged an additional 1d. per unit. This will reduce the council's profit by about £600 a year, but will put the company on a satisfactory basis. The consumers' rates will not be affected by the change.

Warragul, Vic.—Mr. S. Rich, who has been manager of the undertaking of the River Latrobe Hydroelectric Co., has resigned his position in order to take an appointment at Canberra.

Electrical Supply Undertakings of Australia

VICTORIA

Town or City	Supply Authority	Type of Plant	Capacity	Distribution System	No. of Consumers
Alexandra	Shire Council	Suction gas	52 kw.	230 volts d.c.	185
Allansford	State electricity commission	Bulk supply	—	460/230 volts, 50 cycle single phase a.c.	—
Altona	"	"	—	"	—
Alvie	"	"	—	"	—
Ararat	Municipal council	Suction gas	150 kw.	415/240 volts, 50 cycle three phase a.c.	578
Bacchus Marsh	Shire council	Suction gas and crude oil	80 kw.	400/230 volts, 50 cycle three phase a.c.	166
Bairnsdale	A. H. Wood Pty. Ltd.	Suction gas	90 kw.	460/230 volts, d.c.	—
Ballarat	Electric Supply Co. of Victoria Ltd.	Steam	4,120 kw.	440/220 volts d.c., and 400/230 volts, 50 cycle three phase a.c.	4,749
Barwon Heads	State electricity commission	Bulk supply	—	460/230 volts, 50 cycle single phase a.c.	—
Beeac	"	"	—	"	—
Belgrave	Belgrave and Gully Electric Supply Co.	Steam	75 kv.a.	230 volts, 50 cycle single phase a.c.	350
Benalla	Shire council	Crude oil	120 kv.a.	400/230 volts, 50 cycle three phase a.c.	350
Bendigo	Electric Supply Co. of Victoria Ltd.	Steam	4,150 kw.	440/220 volts d.c., and 400/230 volts, 50 cycle three phase a.c.	4,025
Beulah	Karkarooc shire council	Suction gas	20 kw.	460/230 volts d.c.	113
Birchip	Birchip Electric Supply Co. Ltd.	"	69 kw.	230 volts d.c.	195
Birregurra	State electricity commission	Bulk supply	—	460/230 volts, 50 cycle single phase a.c.	—
Boolarra	"	"	—	"	—
Boort	Boort Co-operative Butter Co.	Suction gas	48 kw.	230 volts d.c.	134
Box Hill	Nunawading shire council	Bulk supply	—	400/200 volts, 50 cycle single phase a.c.	2,936
Brunswick	City council	"	—	400/230 volts, 50 cycle three phase a.c.	6,500
Camperdown	State electricity commission	"	—	"	—
Carrum	Carrum Electric Supply Co. Ltd.	"	—	460/230 volts, 50 cycle single phase a.c.	1,100
Casterton	Casterton Electric Supply Co.	Suction gas	100 kw.	230 volts d.c.	265
Castlemaine	Castlemaine Electric Supply Co. Ltd.	"	100 kw.	460/230 volts d.c.	469
Charlton	Charlton Electric Light and Power Co. Ltd.	"	45 kw.	230 volts d.c.	301
Chiltern	Shire council	"	30 kw.	"	85
Cobden	State electricity commission	Bulk supply	—	400/230 volts, 50 cycle three phase a.c.	—
Cobram	Tungamah shire council	Suction gas	35 kw.	230 volts d.c.	133
Coburg	City council	Bulk supply	1,650 kv.a.	400/230 volts, 50 cycle three phase a.c.	3,343
Cohuna	Federal Milk Pty. Ltd.	Steam	65 kw.	230 volts d.c.	189
Colac	State electricity commission	Bulk supply	—	400/230 volts, 50 cycle three phase a.c.	670
Coleraine	Coleraine and Western District Butter Factory Co.	Suction gas	46 kw.	230 volts d.c.	142
Cororooke	State electricity commission	Bulk supply	—	460/230 volts, 50 cycle single phase a.c.	—
Cowwarr	State electricity commission	Bulk supply	—	460/230 volts, 50 cycle single phase a.c.	—
Dandenong	"	"	—	400/230 volts, 50 cycle three phase a.c.	—
Daylesford	I. R., G. P. and Telegraph Co. Ltd.	Suction gas	40 kw.	460/230 volts d.c.	430

Electrical Supply Undertakings of Australia—(Continued).
VICTORIA

Town or City	Supply Authority	Type of Plant	Capacity	Distribution System	No. of Consumers
Dimboola	Shire council	Suction gas	58 kw.	460/230 volts d.c.	339
Donald	"	"	129 kw.	230 volts d.c.	400
Doncaster	"	Bulk supply	—	400/200 volts, 50 cycle single phase a.c.	330
Drouin	State electricity commission	"	—	400/230 volts, 50 cycle three phase a.c.	—
Drysdale	"	"	—	460/230 volts, 50 cycle single phase a.c.	—
Eaglehawk	Municipal council	Suction gas	85 kw.	460/230 volts d.c.	650
Echuca	State electricity commission	"	125 kv.a.	400/230 volts, 50 cycle three phase a.c.	—
Elmore	Elmore Electric Light and Power Co.	Steam	45 kw.	460/230 volts d.c.	162
Essendon	State electricity commission	Bulk supply	—	400/230 volts, 50 cycle three phase a.c.	—
Euroa	Shire council	Suction gas	44 kw.	230 volts d.c.	310
Flemington	State electricity commission	Bulk supply	—	400/230 volts, 50 cycle three phase a.c.	—
Footscray	City council	"	—	400/230 volts, 50 cycle three phase a.c., and 400/200 volts, 50 cycle single phase a.c.	7,000
Frankston	Shire council	"	—	460/230 volts, 50 cycle single phase a.c.	200
Geelong	Melbourne Electric Supply Co. Ltd.	Steam	10,500 kw.	400/230 volts, 50 cycle three phase a.c., and 460/230 volts d.c.	6,400
Gisborne	Shire council	—	—	230 volts d.c.	105
Hamilton	Hamilton Electric Supply Co. Ltd.	Suction gas	273 kw.	460/230 volts d.c., and 400/230 volts, 50 cycle three phase a.c.	752
Healesville	Shire council	"	170 kv.a.	400/230 volts, 50 cycle three phase a.c.	338
Heathcote	McIvor shire council	"	42 kw.	230 volts d.c.	178
Heidelberg	Shire council	Bulk supply	—	400/200 volts, 50 cycle single phase a.c.	3,140
Hepburn	Hepburn Springs Electric Supply Co.	—	—	—	—
Heyfield	State electricity commission	Bulk supply	—	400/230 volts, 50 cycle three phase a.c.	—
Hopetoun	Karkaroc shire council	Suction gas and crude oil	41 kw.	230 volts d.c.	114
Horsham	Horsham Electric Supply Co.	Suction gas and crude oil	195 kw.	460/230 volts d.c.	696
Inglewood	Municipal council	Steam	50 kw.	230 volts d.c.	130
Jeparit	H. J. W. Block	Suction gas	31 kw.	"	138
Kaniva	Lawloit shire council	—	—	—	—
Kerang	Shire council	Suction gas	152 kw.	230 volts d.c.	413
Kilmore	"	"	53 kw.	"	163
Koroit	Municipal council	"	—	"	142
Korumburra	State electricity commission	Bulk supply	—	400/230 volts, 50 cycle three phase a.c.	—
Kyabram	Kyabram Butter Factory Co.	Suction gas	80 kw.	460/230 volts d.c.	352
Kyneton	Municipal council	"	135 kw.	400/230 volts, 50 cycle three phase a.c.	377
Leongatha	State electricity commission	Bulk supply	—	400/230 volts, 50 cycle three phase a.c.	—
Lilydale	"	"	—	460/230 volts, 50 cycle single phase a.c., and 400/230 volts, 50 cycle three phase a.c.	840
Lorne	Winchelsea shire council	Crude oil	—	—	73

Electrical Supply Undertakings of Australia—(Continued).

VICTORIA

Town or City	Supply Authority	Type of Plant	Capacity	Distribution System	No. of Consumers
Maffra	State electricity commission	Bulk supply	—	400/230 volts, 50 cycle three phase a.c.	250
Mansfield	Shire council	Suction gas	35 kw.	230 volts d.c.	182
Maryborough	Municipal Council	Bulk supply	—	400/230 volts, 50 cycle three phase a.c.	300
Melbourne	City council	Steam and bulk supply	21,300 kw. and 11,000 kw.	400/230 volts, 50 cycle three phase a.c., and 460/230 volts d.c.	17,758
"	Melbourne Electric Supply Co. Ltd.	Steam and bulk supply	17,500 kw. and 15,000 kw.	400/200 volts, 50 cycle single phase a.c.	93,000
"	Victorian railway commissioners	Steam	65,000 kw.	20,000 volts, 25 cycle three phase a.c. Supplies electric railways.	—
"	State electricity commission	Steam	62,500 kw. (at Yallourn) 30,000 kw. (at Newport)	400/230 volt, 50 cycle three phase a.c., and bulk supplies	—
Mildura	Municipal council	Steam and suction gas	—	460/230 volts d.c.	800
Minyip	Dunmunkle shire council	Suction gas	25 kw.	230 volts d.c.	122
Mirboo North	State electricity commission	Bulk supply	—	400/230 volts, 50 cycle three phase a.c.	—
Moe	"	"	—	"	—
Mooroopna	Rodney shire council	Suction gas	25 kw.	230 volts d.c.	155
Mornington	Shire council	Bulk supply	—	400/230 volts, 50 cycle three phase a.c.	354
Mortlake	State electricity commission	"	—	"	—
Morwell	Municipal council	"	—	"	—
Murrayville	Siemerings Pty. Ltd.	Delco light	—	32 volts d.c.	2
Murtoa	Dunmunkle shire council	Suction gas	55 kw.	230 volts d.c.	214
Nagambie	Goulburn shire council	"	49 kw.	"	150
Nathalia	Numurkah shire council	Suction gas and crude oil	75 kw.	460/230 volts d.c.	214
Nhill	Lowan shire council	Suction gas	100 kw.	"	241
Noorat	State electricity commission	Bulk supply	—	400/230 volts, 50 cycle three phase a.c.	—
Northcote	City council	"	1,140 kv.a.	400/200 volts, 50 cycle single phase a.c.	7,400
Numurkah	Shire council	Suction gas	90 kw.	230 volts d.c.	354
Ocean Grove	State electricity commission	Bulk supply	—	460/230 volts, 50 cycle single phase a.c.	—
Orbost	Orbost Butter and Produce Co.	Suction gas	65 kw.	230 volts d.c.	230
Ouyen	Walpeup shire council	Delco light	9 kw.	110 volts d.c.	15
Point Lonsdale	State electricity commission	Bulk supply	—	460/230 volts, 50 cycle single phase a.c.	—
Portarlington	"	"	—	"	—
Port Melbourne	City council	"	900 kw.	400/230 volts, 50 cycle three phase a.c.	1,500
Preston	Municipal council	"	—	400/200 volts, 50 cycle single phase a.c.	1,100
Quambatook	Kerang shire council	—	—	—	—
Queenscliff	State electricity commission	Bulk supply	—	400/230 volts, 50 cycle three phase a.c.	—
Rainbow	Rainbow Electric Supply Co.	Suction gas	35 kw.	230 volts d.c.	112
Rochester	Commonwealth Electric Co. Pty. Ltd.	Suction gas and crude oil	90 kw.	"	405
Rupanyup	Dunmunkle shire council	Suction gas	30 kw.	"	112
Rushworth	Waranga shire council	Suction gas and crude oil	65 kw.	"	250
Rutherglen	Shire council	Suction gas	25 kw.	460/230 volts d.c.	193
Sale	State electricity commission	Bulk supply	—	400/230 volts, 50 cycle three phase a.c.	—

Electrical Supply Undertakings of Australia—(Continued).

VICTORIA

Town or City	Supply Authority	Type of Plant	Capacity	Distribution System	No. of Consumers
Sea Lake	Wycheproof shire council	Suction gas	39 kw.	230 volts d.c.	135
Seymour	Shire council	"	100 kv.a.	400/230 volts, 50 cycle three phase a.c.	303
Shepparton	State electricity commission	"	50 kw.	460/230 volts d.c.	523
Sorrento	Flinders shire council	Suction gas	28 kw.	230 volts d.c.	195
St. Arnaud	Municipal council	Crude oil	80 kv.a.	400/230 volts, 50 cycle three phase a.c.	120
Stawell	"	Suction gas	125 kv.a.	"	390
Sunbury	Bulla shire council	"	100 kw.	230 volts d.c.	142
Sunshine	H. V. McKay Pty. Ltd.	Bulk supply	—	"	500
Swan Hill	Municipal council	Crude oil	500 h.p.	400/230 volts, 50 cycle three phase a.c.	555
Tatura	Tatura Butter Factory Co.	Suction gas	25 kw.	230 volts d.c.	220
Terang	State electricity commission	Bulk supply	—	400/230 volts, 50 cycle three phase a.c.	—
Toora	Toora and Foster Electric Supply Co.	Hydroelectric	100 kw.	415/240 volts, 50 cycle three phase a.c.	140
Trafalgar	State electricity commission	Bulk supply	—	400/230 volts, 50 cycle three phase a.c.	—
Traralgon	"	"	—	"	—
Trentham	Municipal council	Suction gas	20 kw.	"	—
Tyers District	State electricity commission	Bulk supply	—	460/230 volts, 50 cycle single phase a.c.	—
Wahgunyah	Rutherglen shire council	"	—	240 volts d.c.	48
Wangaratta	Municipal council	"	—	400/230 volts, 50 cycle three phase a.c.	566
Warburton	Upper Yarra shire council	—	—	230 volts d.c.	120
Warragul	River Latrobe Hydro-Electric Co. Ltd.	Hydroelectric	380 kv.a.	400/230 volts, 50 cycle three phase a.c.	200
Warrion	State electricity commission	Bulk supply	—	460/230 volts, 50 cycle single phase a.c.	—
Warrnambool	"	"	—	400/230 volts, 50 cycle three phase a.c.	—
Werribee	"	"	—	"	—
Williamstown	City council	"	2,000 kw.	"	3,871
Winchelsea	State electricity commission	"	—	460/230 volts, 50 cycle single phase a.c.	—
Wodonga	Wodonga Electric Supply Pty Ltd.	Suction gas	45 kw.	230 volts d.c.	193
Wonthaggi	State coal mine	Steam	1,875 kv.a.	415/240 volts, 50 cycle three phase a.c.	720
Woodend	Newham and Woodend shire council	Suction gas	70 kw.	230 volts d.c. and 110 volts, 50 cycle single phase a.c.	150
Wycheproof	Shire council	"	38 kw.	230 volts d.c.	181
Yallourn	State electricity commission	Bulk supply	—	400/230 volts, 50 cycle three phase a.c.	—
Yarragon	"	"	—	"	—
Yarram	Yarram Hydro-Electric Co.	Hydroelectric and suction gas	150 kv.a.	"	260
Yarrawonga	Municipal council	Suction gas	45 kw.	230 volts d.c.	292

Current Prices for Electrical Supplies

The quotations in this list represent the average retail selling prices ruling in Melbourne during the month of publication. These prices are subject to bona fide traders' discounts. Special rates are obtainable in most cases for large quantities. In general Sydney prices are slightly lower.

Adaptors—				Conduit Fittings—			
Hardwood	doz.	11/3		Saddles	gross	5/	5/ 5/5
Parallel	each	6/6					½ & ¾ in. ¾ in.
Blocks—				Screwed tees	doz.	5/5	7/6
3 in. round	gross	22/6		" elbows	doz.	3/9	5/5
3½ in. round	gross	25/		" couplings	doz.	2/9	4/
6 in. x 3 in. rectangular	doz.	6/8		" bell mouths	doz.	5/5	5/5
9 in. x 3 in. rectangular	doz.	8/9		" " 1 in.	doz.	14/10	
6 in. x 6 in. square	doz.	12/6		" " 1½ in.	doz.	19/6	
Bushes—				" " 1½ in.	doz.	27/	
½ in. ideal metal	gross	7/6		Junction Boxes—			
¾ in. ideal metal	gross	7/6				½ in. & ¾ in.	¾ in.
Bushes—				2-way	doz.	10/10	10/10
½ in. ideal metal	gross	8/9		3-way	doz.	11/3	11/3
¾ in. plain wooden	doz.	1/6		4-way	doz.	11/3	11/3
1 in. plain wooden	doz.	1/8		Fuses (Cut-outs)—			
1 in. plain wooden	doz.	2/				British	Japan
Bells and Bell Material—				5 amp, anchor type	doz.	11/3	6/3
Bell transformers	each	12/6		5 amp, round chamber	doz.	17/6	8/9
1½ volt dry cells	each	3/4		8 amp, round chamber	doz.	25/	12/6
Bell wire—1/029 d.c.c.	1,000 yd.	32/6		10 amp, oblong	doz.	45/	25/
1/036 d.c.c.	1,000 yd.	42/6		20 amp, oblong	each	—	3/
1/029 d.c.c. and i.r.	1,000 yd.	50/		Holders—			
1/036 d.c.c. and i.r.	1,000 yd.	60/				English	Japan
No. 2 porous pots	each	2/1		C/G., S.C. holders	doz.	13/4	9/2
No. 2 jars	doz.	8/9		½ in. and ¾ in. holders	doz.	13/4	9/2
No. 2 zincs	each	1/3		Batten holders	doz.	15/	11/3
Salammoniac	lb.	1/3		Lamps—			
2½ in. wood box bells	each	4/6				Metal Filament, Vacuum Type	
2½ in. iron box bells	each	4/6		25 to 250 volts, 20 to 60 watt	each	2/	
3 in. wood (church gong)	each	18/4		20 to 250 volts, 100 watt	each	5/	
Bell presses	from each	3/9				Gas-filled Type	
Pocket Lamp Batteries—				20 to 250 volts, 25 to 40 watt	each	2/9	
Batteries, pocket lamp	each	1/10		All voltages {			
2-cell batteries	each	2/5					
3-cell batteries	each	2/8					
Ceiling Roses—							
		English	Japan				
2-plate	doz.	11/3	6/3				
3-plate	doz.	15/	8/9				
Connectors—							
1-way, porcelain	doz.	2/6		60 watt	each	3/3	
2-way, porcelain	doz.	4/		75 watt	each	3/9	
3-way, porcelain	doz.	5/		100 watt	each	5/3	
Counterweights—				150 watt	each	7/	
Porcelain	each	2/6		200 watt	each	9/	
Brass	each	5/6		300 watt	each	13/	
Shot for same	lb.	6½d.		500 watt	each	17/6	
Casing and Cover—				750 watt	each	22/6	
Best white pine	100 ft.	12/6		1000 watt	each	27/6	
Conduit—				1500 watt	each	40/	
		Plain	Screwed	Carbon Filament			
½ in.	100 ft.	10/	22/6	All voltages, 5 to 32 candle power	doz.	24/	
¾ in.	100 ft.	10/10	22/6	All voltages, 50 candle power	doz.	42/	
1 in.	100 ft.	16/3	30/	Plugs—			
1½ in.	100 ft.	27/6	42/6	5 amp two pin plugs	doz.	32/6	
2 in.	100 ft.	45/	70/	5 amp two pin tops	doz.	15/	
2½ in.	100 ft.	68/	100/	Switches—			
3 in. oval	100 ft.	12/6	—			English	
Conduit Fittings—				5 amp s.p. pol. brass	doz.	18/9	
Grip—Tees	doz.	3/6	3/6 4/3	5 " s.p. ox. copper	doz.	21/6	
" Elbows	doz.	2/9	2/9 3/6	5 " 2-way pol. brass	doz.	32/6	
" Couplings	doz.	2/3	2/3 2/9	5 " 2-way ox. copper	doz.	38/6	
Crampets	gross	5/5	5/5 6/3	10 amp. s.p. pol. brass	doz.	40/	

Switches—		English	Tape—
3	" American tumbler	doz. 25/	Black adhesive lb. 2/9
3	" s.p. indicating rotary	doz. 27/6	Pure rubber lb. 10/
3	" s.p. non-indicating rotary	doz. 23/5	
3	" 2-way rotary	doz. 56/3	
5	" d.p. indicating rotary	doz. 62/6	
10	" d.p. indicating rotary	doz. 78/	
20	" d.p. indicating rotary	doz. 150/	

Switchboards—		English	Japan
Single circuit marble 5 amp .. each	11/3	9/2	
Single circuit marble 10 amp .. each	18/9	16/3	
Two circuit marble 5 amp .. each	20/	16/3	
Two circuit marble 10 amp .. each	25/	22/	

Switchboard Frames—		English	Japan
6 in. x 6 in. local make	doz. 9/6		
6 in. x 8 in. local make	each 1/		
8 in. x 8 in. local make	each 1/3		
8 in. x 10 in. local make	each 1/6		
10 in. x 10 in. local make	each 1/8		

Wire and Cables—		Per 1,000 yd.
1/.044, 600 meg.		£5 12 6
1/.064, 600 meg.		£8 12 6
3/.036, 600 meg.		£9 15 0
7/.036, 600 meg.		£17 0 0
7/.044, 600 meg.		£21 10 0
7/.064, 600 meg.		£36 10 0

Flexibles—		Per 100 yd.
23/36 cotton		£2 2 6
40/36 cotton		£2 12 6
70/36 cotton		£3 10 0
110/36 cotton		£4 5 0

Electrical Contracts

COMMONWEALTH

Dept. of Works and Railways.—Seven motors at City South Telephone Exchange, Sydney—Siemens Bros and Co.; electric motors at telephone exchange, Newmarket, Queensland—Noyes Bros. (Sydney) Ltd.; power and electric light installation, Sth. Melbourne telephone exchange, and Canterbury telephone exchange—Parry and Taylor; installation of electric light and power, Sydney G.P.O.—Julius Colin and Co.

P.M.G.'s. Dept., General.—590 telephones, and 670 generators—Ericsson Telephone Manuf. Co.; 335 telephones, and 200 switches—British General Elec. Co.; 4,000 transmitter insets—Phoenix Telephone and Electric Works.

P.M.G.'s. Dept., N.S.W.—30 tons galv. iron wire, 200 lb. per mile—Rylands Bros. (Aust.) Ltd.; 40 strips of registers, mounted in strips of 10—Western Elec. Co.

P.M.G.'s. Dept., Victoria.—Switchboards, N.S.W. and S.A.—Western Electric Co. (Aust.) Ltd.; cords, all states—Reliance Electrical Wire Co. (through High Commissioner, London); switches, extension—Phoenix Telephone and Electric Works Ltd. (J. B. Wallis Ltd.); generators, Vic., Q'land., S.A., W.A. and Tas—Ericsson Telephone Mfg. Co.; pedestal sets and hand sets, all states—Ericsson Telephone Mfg. Co.; lead-covered cable—W. T. Henley's Telegraph Works Co. Ltd.; bronze and cadmium copper wire, all states—Thos. Bolton; bronze and cadmium copper wire, all states—Fredk. Smith; two Kleinschmidt perforators, and 1,000 lb. tape—Kleinschmidt Electric Co. Inc.; 400 registers—Western Electric Co. (Aust.) Ltd.

STATES

N.S.W. Public Works Dept.—Installation electric light, West Maitland court house—Dunn and Vaughan; electric light and power, Grafton hospital—McKenna and Smith.

Sth. Aust. Supply and Tender Board.—1,000 caustic soda battery cells and renewals—General Railway and Signal Co.

State Electricity Commission of Vic.—22,000 v. lightning arresters—Aust. General Elect. Co. Ltd., Aust. Westinghouse Elect. Co. Ltd.; disconnecting switches—Metropolitan Vickers (Aust.) Pty. Ltd.

Vic. Public Works.—Installation of electric motors, Collingwood Technical School—J. March; installation of electric light, Footscray Domestic Arts School—McDonald and Co.

Victorian Railways.—Hard drawn stranded copper cable—British Insulated and Helsby Cables Ltd.; stranded copper cable, 91/.044—British Insulated and Helsby Cables Ltd.; radiators, electric, half-kilowatt, Hecla "Excel"—Warburton Franki (Melb.) Ltd.; copper telephone wire and accessories—British Insulated and Helsby Cables Ltd.; insulated cable—Noyes Bros. (Melb.) Pty. Ltd.; petrol driven d.c. electric welding set, with accessories and spares—Robt. Bryce and Co. Pty. Ltd.

GENERAL

Melbourne City Council.—Motor generator—Metropolitan Vickers Electrical Co.; brush contacts—Australian General Electric Co. Ltd.; wood board separators—Tudor Accumulator Co. Ltd.; material for turbine blading, generating plant—English Electric Co. of Aust.; turbine diaphragms, blading and other parts—Metropolitan Vickers Electrical Co. Ltd.

Sydney City Council.—Double braided weatherproof cables—Enfield Cable Works (A'sia.) Ltd.; 10,000 volt feeder protective apparatus, 5,000 volt potential transformers—Australian General Electric Co. Ltd.; a.c. consumers meters—Electricity Meter Mfg. Co.; h.t. switch panels for 5,000 and 10,000 volt substations—Ferguson Pailin Ltd.; 30,000 electricity meter coils—Weldon Electric Supply Co. Ltd.

NEW ZEALAND

Dunedin City Council.—Rails, fishplates, bolts, etc.—Preece, Cardew and Rider; 2 miles triple braided tramway feeder cable—Lawrence and Hanson Electrical Co. Ltd.; 6 miles B. and S. No. 00 gauge trolley wire—Carrick Wedderspoon Ltd.

Grey Electric Power Board.—Copper wire: triple braided aerial cable—Turnbull and Jones Ltd.; copper clad steel wire—Carrick Wedderspoon Ltd.; extra high tension insulators—A. D. Riley and Co. Ltd.; low tension insulators—Turnbull and Jones Ltd.

TENDERS OPEN

COMMONWEALTH

P.M.G.'s. Dept., General.—July 14—Cable terminals. Aug. 11—Plugs and sleeves, switchboard cords. Sept. 15—Lamps, lamp caps, and lamp sockets, telegraph equipment. Sept. 29—Protective apparatus.

P.M.G.'s. Dept., N.S.W.—Nov. 6—Automatic common battery, telephone equipment.

P.M.G.'s. Dept., Victoria.—Aug. 25—Pneumatic tubes. Nov. 6—Automatic common battery telephone equipment, Canberra exchange.

STATES

N.S.W.—Public Works Dept.—June 29—Steel towers for transmission lines, Barren Jack. Aug. 4—Electrically driven pumping plant, Blackheath. Sept. 14—Electrical equipment for Cook's River bridge. Sept. 21—Telephone communication system, Barren Jack hydroelectric development.

N.S.W. Railways and Tramways.—July 8—Two coal elevators for White Bay power house, two 150 kv.a. transformers. July 15—Three 100 kv.a. transformers. Aug. 5—Ash conveyors for White Bay power house. Sept. 9—Electric travelling jib crane. Oct. 7—2,000 kw. turbo alternator.

State Electricity Commission of Vic.—June 15—Bare hard drawn copper cable. June 29—Lead storage batteries, V.I.R. cable. July 6—22,000 volt current limiting reactors. Aug. 3—Switchgear and accessory equipment. Sept. 14—3,000 kv.a. transformers and spares. Sept. 21—250 kv.a. transformers.

Tasmanian Hydro Electric Dept.—June 30—Material for 88,000 volt transmission line.

Victorian Railways.—June 17—Two phase a.c. induction motors, starting apparatus and accessories. June 24—20,000 volt air break switches, outdoor type, copper plates. July 1—Electric cables (spares). July 8—Double recording instrument copper plates. July 29—Point detection transformers. Aug. 19—Waterproof copper clad line wire. Aug. 26—Tramway rails and fishplates.

West Aust. Govt. Tender Board.—July 9—One 200 kv.a. transformer.

GENERAL

Healesville Shire Council, Vic.—June 19—Transformers, cable insulators, switchboard extension.

Katoomba Municipality, N.S.W.—June 30—Boilers, 500 kw. generator, switchgear, transformers, switches, lighting arresters, substation switchboards.

Maffra Sugar Factory, Vic. (Fyvie and Stewart, Melbourne).—June 19—Two water tube boilers, two boiler feed pumps, steam alternator. June 22—A.C. motors.

Melbourne and Metropolitan Tramway Board.—June 23—Steelwork for tramway crossings and junctions. June 30—Special work for junctions. July 14—Special work for junction.

Met. Water, Sewerage and Drainage Board, Sydney.—June 19—Steam generating set.

Orange Municipality, N.S.W.—July 1—Boiler, economiser and accessories.

Sydney City Council.—July 27—5,000 kv.a. transformer, gas filled lamps.

NEW ZEALAND

Franklin Electric Power Board.—June 30—11,000 volt insulators, bare copper wire, triple braided and insulated wire, outdoor service fuses, testing instruments and oil drying equipment, wattmeters and transformers. July 14—Galv. steel wire.

Invercargill Borough Council.—June 22—Copper cable. Aug. 17—Single phase transformers, underground cable.

Public Works Dept.—June 23—Portable oscillograph.

Thames Valley Elec. Power Board.—July 27—15, 11,000 volt transformers.

LOAD INDICATOR FOR TRANSFORMERS

The thermotel, a device for studying the load carried by a transformer, has been developed by the General Electric Co. of America. If a transformer is carrying too much of a load, a semaphore is tripped and swung into view. The attention of the operator is thus called to the condition. The need for such an instrument has long been felt by the distribution engineer, as up to the present time there has been no practical way of keeping reliably informed as to the load conditions on distribution transformers.

The thermotel consists fundamentally of two thermometers connected in series. The first is affected by the heat of the top oil of the transformer, and the second by the outside temperature. The composite reading is translated on a dial to show the load which the transformer is carrying. Readings in excess of 100 per cent show that the transformer is too small since it has carried a continuous load or a short time overload sufficient to bring the temperature of the internal windings to 100 deg. C. or higher.

The device is installed by lifting the cover

from the transformer and slipping over the edge of the tank the arm which supports the indicating dial on the outside of the tank. Readings can be made from the ground by the inspector.

Proposals are under consideration providing for an increase in the capital of the Adelaide Electric Supply Co. Ltd., from £2,000,000 to £2,250,000, by the creation of 250,000 shares of £1 each.

TAMAKI ROAD BOARD

POWER PLANT FOR SALE

The above Board having made provision for a power supply in bulk, invite 3 tenders for the purchase of the whole or portion of its Electric generating plant, consisting of 2-400 V. 50 per. 3 phase alternators, 2 suction gas engines, producers and auxiliaries.

No. 1 set is of 50 Kv.a. output belt-driven by a 75 B.H.P. engine.

No. 2 set is of 100 Kv.a. output direct coupled to a 4 cycle, 176 B.H.P. vertical engine.

Tenders for either engine or alternator of No. 1 set separately would be considered.

Tenders close 30th June, at the Board's Office, St. Heliers.

Further particulars upon application to the Electrical Engineer.

St. Heliers, N.Z.

Tamaki Road Board.





Editorial





ESSENTIALS AND AIDS IN ELECTRICAL MERCHANDISING

The keen competition of modern business has elevated salesmanship almost to the status of a science. No longer is it sufficient to display a certain amount of stock, and have an attendant to supply customers and take the cash. The stock must be exhibited in such a manner that it will attract the attention of the prospective customer and awaken in him the desire to possess the article he sees displayed, whilst the salesman must have some technical knowledge of the goods he is trying to sell. This applies very strongly to electrical goods which are too often regarded as luxuries rather than absolute necessities. Electrical apparatus must be handled by the retailer in such a way that the public will be educated into regarding the various comfort-giving and labor-saving devices as essential to existence under modern conditions. This may appear a tall order, but it is the end which must be kept in view.

In general, the nature and construction of electrical household apparatus is such that it will readily lend itself to attractive arrangement. The plated and burnished metal parts are in themselves attractive, and if each piece of apparatus is allowed to exhibit its individuality it will inevitably draw notice upon itself. Thus, the first point to be observed is to display goods sparingly, that is, to avoid jumbling a bundle of everything into the showroom or window. A heterogeneous mass of appliances gives the eye nothing to rest upon and creates no fixed impression. This does not mean that mass effects are to be avoided. Grouping should be designed to draw attention to only a few articles. Mass dry cells, irons, or radiators, but do not bunch the lot together without sense of law and order. A liberal allowance of empty space in the showroom is as impressive as white paper in a properly designed advertisement. In addition to care in placing, it is essential that every article must be clean. Dusty stock is an insult to the customer, and must be dealt with as such.

But the most artistic and restrained placing, coupled with spotless cleanliness, will fail if the lighting is poor. Particular attention, therefore, must be given to illumination. In the showroom this is not difficult for there are usually sufficient lamps alight for the purpose of displaying shades and globes to provide a reasonable and even light. The window, however, is different. Here good lighting is the pre-eminent requirement. The window is the face of the shop; through it the passer-by draws

his impression of the stock within and often, also, of the selling capabilities of the shopkeeper. Good window lighting means lighting that will attract attention but will not fatigue the eyes however long one may gaze. Lighting intensities that are adequate for ordinary requirements are insufficient when applied to a shop window. One of the essentials is that the source of light should be unseen. Involuntarily the eye is drawn to the brightest object within range, therefore, when the lamps are visible, attention is drawn away from the goods displayed. A converse effect to that of unshielded light sources may be obtained by the use of spotlights for drawing attention to some particular piece of apparatus. Color screens on lighting units allow of very attractive variations in illumination being made. The humble flasher is an effective selling agent, for movement will attract attention quicker than anything. Movement, however, must be used with restraint as, if overdone, it can produce worse confusion than jumbling.

The advent of radio has given the electrical retailer a new selling agent that may be made very valuable. It is a recognised fact that the average person entering to buy an article such as a lamp can be readily interested in some other appliance, such as a fan, providing it is displayed in an attractive manner. Even if an immediate sale is not effected an interest has been aroused which may result in future business. Radio, in the same way, may be used to draw attention to domestic electric appliances. People who scarcely knew there were electrical shops are now regular patrons, in search of apparatus for their broadcast receivers. It has been said, and with some truth, that there is little to be made from handling radio material, but there is no reason why that material should not be made indirectly profitable. The electrical dealer who handles radio goods should try disposing his stock so that the radio enthusiast cannot avoid giving some notice to the household electric appliances.

But the most attractive display in window and showroom will be only partially successful without the right personnel handling the material. The very best article will lose its appeal unless the selling staff knows how to drive home that appeal to the public. The salesman requires a thorough knowledge of the goods he is handling, a pleasing personality and a working acquaintance with psychology as it affects his relations with his customers. There is no need to be startled at the term psychology. As applied

to salesmanship it covers the quality known as tact, which is born of experience and a knowledge of human nature. The trouble is that in the past this aspect has been rather neglected in the training or development of salesmen. Experience alone has been their teacher in giving them an understanding of how to get a rough appraisal of their customer's tastes from a first glance, and how to approach different kinds of people. Experience is notable for the cost of its attainment, and in this case the cost falls on the establishment instead of the man. Some knowledge of the rudiments and general principles of psychology, of the laws which govern the workings of the human mind, would eliminate most of this cost. Indeed it is this requirement that brings the scientific element into salesmanship.

Coupled with the display and the salesmanship is, of course, the necessity for demonstrating equipment in action. Here we approach a transition to that part of the selling organisation which is outside the shop. Many retailers have well equipped demonstration rooms, and the number is growing, but this is an activity which might be undertaken with better advantage by an association of retailers. One big demonstration organisation, with united effort behind it, will talk louder to the public than a host of small efforts. There is the further point that the capital and running expenditure of a demonstration department are very heavy for a small retailer, and may not be justified by results. Many public supply authorities have established demonstration departments, with a primary view to increasing their energy sales, but there is no reason why the electrical associations should not work on a similar plan for the ultimate good of wholesalers, retailers and the public.

This leads to the idea of an electric house for demonstrating the uses and advantages of domestic electric appliances. This is being put to practical use in many places, and it should commend itself as an attractive form of publicity in connection with exhibitions. The British Electrical Development Association recently made use of the scheme at the Daily Mail ideal home exhibition, with excellent results. A single storey six roomed house was erected. The rooms were decorated and furnished as hall, large dining room with separate lounge, bedroom, bath and dressing room, garage, kitchen, scullery and laundry. In each apartment a complete range of modern British electrical appliances was shown in operation, and the fullest information was made available concerning cost, manner of use, and the monthly or annual expenditure on the energy required for their operation.

These activities lead away from the shop itself to what may be classed as purely outside advertising. Printed advertising is vastly important,

but it is often neglected by the retailer because he cannot see actual results for money spent. This is probably because the advertising is not handled in a manner that will bring results. Newspaper advertising is the most efficient of all, when properly handled, because it reaches many who cannot be reached by any other form of publicity. But the space must be used, just as showroom or window space, in a manner that will attract the eye. Half a dozen words are often more effective and convincing than a mass of closely packed type. It is bad policy to put too much reading matter; be content with making one good point at a time. Further, advertising must be systematic or it is practically useless; it is constant repetition that keeps the advertiser and his products in the public eye.

This is only a summary of points that are essential or will help the electrical retailer. Details have perforce been omitted, but it is attention to detail that makes success. Given the general points, however, thought will reveal the details and enable the retailer to embark on a plan of attraction of the public, both on his actual selling premises and through external media, that will result in mutual satisfaction between merchant and purchaser. Above all, it must be strictly borne in mind that the satisfied customer is the best selling agent and that a reputation for quality goods and square dealing is much easier to lose than to regain.

Notes and Personals

A sum of £1,000 is to be expended by the committee of the Molong hospital, N.S.W., on the installation of electric light and sewerage systems.

Mr. R. B. Hungerford, managing director, Western Electric Co. (Australia) Ltd., Sydney, left by the Orvieto on June 25 for a business visit to England and the United States.

The government of Tasmania has completed the foreclosure of the carbide works at Electrona. The works are now, therefore, the absolute property of the state.

Mr. Henry E. White, of Phillip street, Sydney, has been appointed architect in charge of the new Sydney city council power house at a retaining fee of £1,500.

Mr. F. R. Coombes, B.E., A.M.I.E.E., who recently returned to New Zealand after spending some four years in England, has joined the electrical branch of A. S. Paterson and Co. Ltd.

Mr. J. J. Richardson, principal designing electrical engineer, public works department, N.S.W., has been elected president of the New South Wales branch of the British Astronomical Association.

At a meeting of Parramatta ratepayers it was decided to request the New South Wales railway commissioners to electrify the trams running to the Woollen Mills and Camellia, also to extend the service to Model Farms and Granville.

The Tasmanian government has accepted the tender of Armstrong, Whitworth Pty. Ltd. for the construction of the Shannon hydroelectric works. The installed capacity of the new station will be 12,000 h.p.

Mr. J. M. Bridge, general superintendent of the Victorian electricity commission, Yallourn, will shortly leave for Europe and America to study methods of open cut working and the handling of large quantities of coal.

A committee of the Greater Brisbane council has conferred with Mr. J. S. Just, general manager of the City Electric Light Co., on the question of the acquisition by the council of the company's undertaking.

The Melbourne city council has approved of a recommendation of the electric supply committee that tenders be invited for a 5,500 kw. turbo-alternator, to be substituted for the existing 2,500 kw. machine at the council's power house.

The Brisbane tramway trust has purchased three Albion, three Fageol, and three White motor bus chasses. The bodies for these are in course of construction and the vehicles will be put on the road shortly.

Mr. S. L. Pearce, city electrical engineer of Manchester for 21 years, who recently visited Australia to report on the electric supply undertaking of the Sydney city council, has been appointed one of the electricity commissioners of Great Britain.

Mr. J. R. Brookman, mains engineer of the Adelaide Electric Supply Co. Ltd., has been awarded the degree of Master of Engineering by the university of Adelaide for a thesis on "The Relay Protection of Electrical Circuits." The degree will be conferred at the December commemoration.

The Melbourne and metropolitan tramways board is calling tenders for the conversion of the St. Kilda road cable tramways to the electric system. The first phase of the work will be the construction of a temporary track to carry the traffic during the main conversion.

Mr. W. P. Kirkwood, a member of the syndicate holding the Australian rights of Dr. Lee de Forest's invention, the phonofilm, is at present in Sydney. The contrivance covers the reproduction of the human voice, music, etc., on cinematograph film which synchronises with physical movements of speakers or players in a moving picture. It is hoped to commence Australian manufacture at an early date.

The interruption to the construction of the hydroelectric works at Burrinjuck through the recent floods on the Murrumbidgee river will not be so serious as was at first anticipated. The principal damage done was on the uncompleted portion of the pipe line. It is stated that the plant should be in working order by June next.

The chief engineer of the Brisbane tramway trust has recommended that before any recommendation is made in connection with the tenders for substation equipment recently called, a representative of the trust visit Sydney and Melbourne to enquire into the systems in operation in those cities.

After conference with representatives of the Brisbane tramway trust, the electric light, power and transit committee of the Greater Brisbane council has recommended that, before proceeding with the erection of a large power house, negotiations be entered into with the City Electric Light Co. in regard to acquisition of the company's undertaking.

The members of the Melbourne tramways board, whose term of appointment has recently expired, have been reappointed for a period of four months only. At the end of this period the term of the chairman, Mr. Cameron, will also expire. In the meantime the government will consider proposals for reconstituting the control of the tramways.

Foolishness of a class akin to that of the person who seeks for a gas leak with a lighted match was shown recently by a motorist at Wollongong, N.S.W. His car would not start, so he removed the battery and connected the leads to the 240 volt a.c. town lighting supply. He then attempted to crank the car, but on touching the handle completed the circuit from the chassis to earth, and was killed.

Damages assessed at £550 have been awarded to the parents of the late G. L. Terry of Lilydale, Vic., who was electrocuted in October last while attempting to disentangle his sister who had come in contact with a live wire. The accident was caused through a telephone wire having been left hanging loose and having come in contact with electric supply mains. Defendants were the Lilydale shire council and the Commonwealth government.

The Christchurch tramway board is increasing the cash fares for two-section and three-section riders and the concession fares on the longer trips. The section fares will each be increased by one halfpenny. The board's contract for power supply from Lake Coleridge expires next year and as the public works department is asking for an increase in the price paid for power, it appears that further increases in fares may be made.

The public works committee of the Melbourne city council has recommended that a bulk supply of electricity at 6,600 volts be given to the Coburg council's quarry at Preston. The city council will provide and erect the substation and the suggested charge is £9 per kw. of maximum demand, plus .65d. per unit.

The Greater Brisbane council has decided that it will not be advisable to take over the tramways as from October 1 next. The electric light, power and transit committee has recommended that the government be asked to provide for the tramway trust to remain in control until June 30, 1926.

Mr. H. P. Greenwood, general manager of Metal Manufactures Pty. Ltd., died at Port Kembla, N.S.W., on July 13, after a long illness, at the age of 37. Mr. Greenwood, who was formerly on the staff of the British Insulated and Helsby Cables Ltd., Prescott, England, came to Australia in June, 1917, to take charge of the works, which were then being equipped to produce only bare copper wire and cable. Under Mr. Greenwood's management the industry was successfully developed and plant was installed later for the manufacture of brass and copper tubes, telephone cables, and other lines. Mr. Greenwood was a man of outstanding ability and personality. His loss will be severely felt by his many friends throughout Australia. Mr. Greenwood leaves a widow and two young children.

Mr. Alexander Wyllie, general manager of the Auckland power board and one of the foremost authorities on electrical and scientific matters in New Zealand died on June 5 at the age of 55 years. Mr. Wyllie was born in Adelaide, S.A., and completed his education in Great Britain under eminent engineers. He received an appointment as borough engineer of Walsall, Staffordshire, and came direct from that office in 1907 to take up his position as Auckland city electrical engineer. Under his supervision and control the present electricity business in Auckland was established and extended. The first section of the plant was opened in 1908, and since then the equipment has been augmented until the station is now the largest and most efficient steam-electric plant in New Zealand. When further additions to the plant were planned in 1920, Mr. Wyllie visited Great Britain and secured much of the machinery, which has been installed within the last few years. When, on April 1, 1922, the control of the city electrical equipment was vested in the newly-constituted Auckland power board, Mr. Wyllie was appointed general manager. Last year he visited Australia, and since his return he had experienced indifferent health.

QUEENSLAND ELECTRICAL WORKERS' BOARD

Meetings of the board were held on May 19 and June 2 and 16. A special meeting was also held on June 12. Further reports of breaches of the electrical workers' act were received and are being investigated. A case has also been investigated in which an applicant for examination admitted having furnished a false statement of service. Action befitting the seriousness of the matter was taken—it being recognised that offences of this nature should be severely dealt with.

Certificates of service without examination were granted four fitters, three linesmen, nine mechanics, and a joiner.

INTERRUPTION TO POWER SUPPLY IN SYDNEY

A total cessation of supply from the Sydney city council power station was caused recently through a circuit breaker failing to clear a feeder fault. The city electrical engineer states that the breaker opened but did not break the circuit, and ultimately short-circuited itself, thus leaving a practically dead short on the busbars. In order to clear the trouble it was necessary to take the generators off the bars. Supply was restored gradually through the duplicate busbars, but operations were hindered by the dense volumes of smoke from the disintegrated switch oil and burning insulation. One employee was overcome by the fumes while attempting to restore service, but he subsequently recovered. No blame is attachable to any of the operating staff for the mishap. The faulty switch was wrecked and damage to the extent of about £1,000 was done to the switchboard.

MELBOURNE CITY COUNCIL SUPPLY FAILURE

A complete shut down of the Melbourne city council's generating station was caused recently through the development of a fault on a feeder cable. The fault occurred close to the power house, giving rise to such a heavy current that the circuit breaker failed to clear the damaged cable. In consequence other feeders in the cable tunnel were damaged and the voltage surge caused trouble at various parts of the system and shut down all the generating equipment. A partial service was restored after a few minutes but portions of the system were out of service for some hours. The shut down caused much inconvenience to consumers and resulted in the stoppage of certain of the cable tramway routes which are operated by electric motors. No blame is attachable to the electric supply department or any of its staff for the failure.

The Polarity of Transformers

By R. C. Philipp*

Although transformers are so widely used, the question of their polarity is one that engineers frequently know little about, yet there are many occasions when a clear knowledge of polarity saves much valuable time. For instance, whenever transformers have to be connected up for parallel operation, or in wiring up instrument transformers (i.e., current or potential transformers) for use with polyphase wattmeters, etc. Occasions have arisen only too often when two or more polyphase transformers of similar ratios and characteristics were intended for parallel operation, yet it has been found impossible to connect them together without partially dismantling one and altering the internal connections, owing to the polarity being reversed. To understand polarity, it is necessary to be perfectly clear about the direction of windings,

labels (i.e., reversing the two leads), we reverse the direction of a winding; and, as will be seen later, its polarity.

Consider now the voltages in a transformer. If one winding of a single phase transformer is connected to an alternating source of supply, the impressed electromotive force will cause a current—known as the magnetising current—to flow. This winding is then known as the primary, and it can be imagined that at any particular instant the direction of the impressed e.m.f. is as shown by the double arrows in Fig. 1c. Now this magnetising current magnetises the whole of the iron core, which in turn causes an induced e.m.f. in both windings. It is important to note that the direction of this induced e.m.f. is the same in all turns of both windings, and is in the opposite direction to the impressed

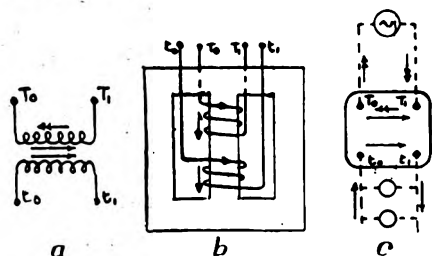


Fig. 1.

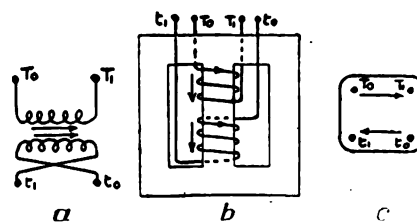


Fig. 2.

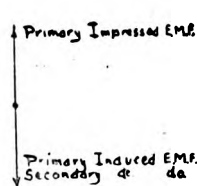


Fig. 3.

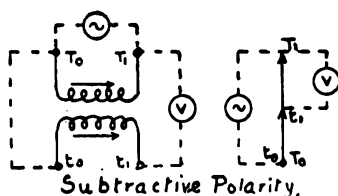


Fig. 4.

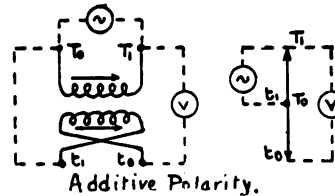


Fig. 5.

also the directions of impressed and induced e.m.f.'s therein, for it is the relation between the above that decides whether a transformer is of additive or subtractive polarity.

Fig. 1b shows two windings in the same direction, while Fig. 2b shows the two windings in opposite directions. Although we speak of clockwise and anti-clockwise winding, it is merely a question as to which end of the winding is labelled "start" and which is the "finish." Considering one individual turn alone it cannot be said to have one direction around the core any more than the opposite direction. A winding assumes a certain direction when one turn only, or a number of turns, are connected in series, and one end is labelled "start" and the other "finish." Obviously, by interchanging these

e.m.f. Thus, altogether there are three separate e.m.f.'s in the two windings, whose relationship is clearly seen from the vector diagram in Fig. 3.

In defining polarity, much misunderstanding has arisen through the confusion of directions of the impressed and induced e.m.f.'s. It is undesirable to compare the impressed e.m.f. in the primary with the induced e.m.f. in the secondary, because the same winding may sometimes be used either as the primary or the secondary, according to whether it happens to be used as a "step up" or "step down" transformer. The simplest and most logical procedure, therefore, is to consider only the induced voltage relations. This has been followed in this article and all single-headed arrows and vector diagrams represent induced voltages only.

Now, it has been seen that as the induced voltages are induced by the same flux, they

*N.S.W. Railways and Tramways Department.

must be in the same direction in each turn; but whether they will appear in the same or opposite directions as viewed from the terminals depends upon the relative directions of the windings. Thus in Fig. 1 the induced voltages are in the same direction relatively to the terminals, and the polarity is, therefore, termed subtractive. In Fig. 2 the induced voltages are in opposite directions relatively to the terminals, and the polarity is then known as additive. These two terms are derived from the standard method of testing for polarity as shown in Figs. 4 and 5.

The procedure adopted when testing single-phase transformers for polarity is:—

- (a) Connect one winding to an a.c. source of supply.
- (b) Bridge one pair of adjacent primary and secondary terminals.
- (c) Connect a voltmeter across the other adjacent primary and secondary terminals.
- (d) If the voltmeter reading is greater than the supply pressure, the polarity is additive.

If the voltmeter reading is less than the supply pressure, the polarity is subtractive.

It is desirable that the markings of the leads should indicate polarity as provided for by the British Engineering Standards Committee and the American I.E.E. standardisation rules. These rules can be stated in this way:—Let the high tension terminals be marked T_o , T_i , etc., and the low tension terminals t_o , t_i , and the transformer connected internally such that at any instant, if the induced voltage in the high tension winding flows from T_o to T_i , the induced voltage in the low tension winding will be flowing from t_o to t_i ; i.e., in both cases from the lower index to the higher. Several manufacturers have adopted this method with advantage, for it enables the polarity to be ascertained at a glance. It will be seen that the same notation has been adopted in the diagrams.

Now the polarity of polyphase transformers, although at first sight more involved than in the case of single-phase transformers, is not difficult to understand if the preceding examples have been carefully followed and the diagrams checked, for the reasoning is identical in both cases. Once again, the principles are best explained by examples, and with that in view Figs. 6-9 have been prepared. Take, for example, Fig. 6, and consider, say, the left-hand limb only, as though one were dealing with a single-phase transformer. It will be seen that the induced voltages in both high and low tension windings are flowing upwards and towards the terminals. (The little closed and open circles shown represent the start and finish of the windings and help in the construction of the vector diagrams.) As stated before, when the induced voltages both flow in the same direction relative to the

terminals, the polarity is considered to be subtractive. Fig. 7 is also of subtractive polarity for the same reason, but the delta terminals in this case belong to different windings; for instance, in the former case terminal a was connected to windings 1 and 3, whereas in the latter case terminal a is connected to windings 1 and 2, with the result that there is a phase difference between them of 60 deg. It is apparent that these two transformers will not operate

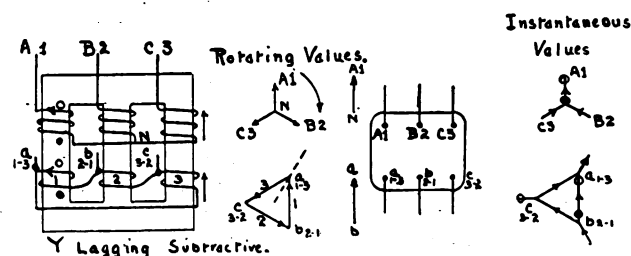


Fig. 6.

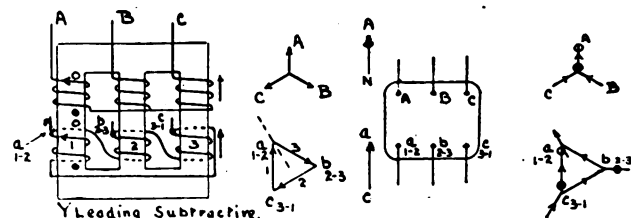


Fig. 7.

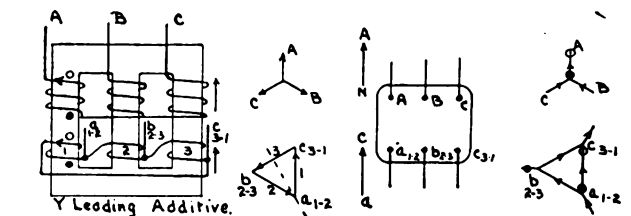


Fig. 8.

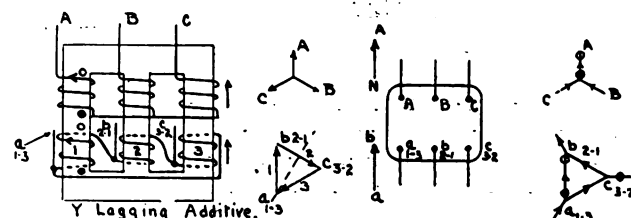


Fig. 9.

in parallel as they are. Both rotating and instantaneous vectors are shown in all four diagrams for comparison, and the single vectors corresponding to No. 1 winding (A phase) have been set out separately. It will be noticed that in the case of the subtractive polarities both h.t. and l.t. vectors point towards A and a, whereas in the case of the additive polarities while the h.t. vector is towards A the l.t. vector is from a. It is interesting to note that, although these four examples have different polarities and

phase displacements, yet the relative phase rotation of both high and low tension sides is in the same direction.

Similar phase rotation is most clearly defined by imagining a three-phase motor with terminals 1, 2 and 3 connected to A, B and C respectively of the high-tension side of a transformer and running in, say, a clockwise direction, and then transferred to the low-tension side and again terminals 1, 2 and 3 connected to a, b and c respectively. Then, if the phase rotation of the transformer is the same relative to both sets of windings, the motor will again run in

phase supply connected to A, B and C. The voltage is read between B-A, B-b, C-A, and C-c, from which the polarity will be known as additive or subtractive, according to whether B-b and C-c are greater or less than B-A and C-A respectively.

Although it is not within the scope of this article to illustrate all the many possible connections and their polarity diagrams—for it must be remembered that there are 12 different ways of internally connecting up either a star-star, a star-delta, or delta-delta combination—yet, if the examples given above have been carefully

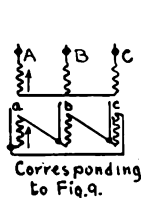


Fig. 10.

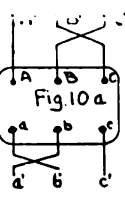


Fig. 10a.

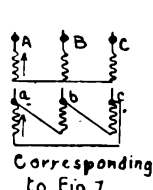
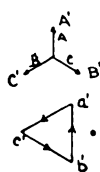


Fig. 11.

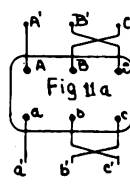


Fig. 11a.

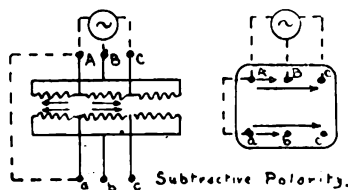
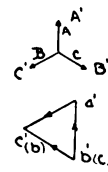


Fig. 12.

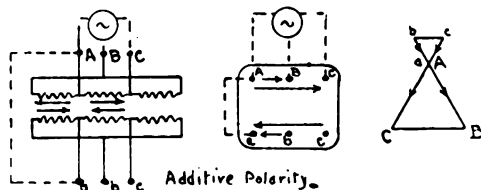


Fig. 13.

a clockwise direction. If the phase rotation is opposed, the motor will, of course, run in an anti-clockwise direction.

Although none of these four transformers will operate in parallel as they stand, yet, strange as it may appear at first sight, any two of them may be made to operate in parallel by simply changing over either or both the high-tension and low-tension terminals. Two examples will make this clear; for instance, if it is necessary for transformers in Figs. 6 and 9 to run in parallel, this can be accomplished by simply crossing two of the external leads on both sides of the transformer in Fig. 9, as shown in Fig. 10a. It will then have exactly the same voltage diagram as Fig. 6 and the two will operate in parallel satisfactorily. Again, if it is desired to run the transformer in Fig. 7 in parallel with that in Fig. 6, it will be necessary to change the leads of the transformer on both h.t. and l.t. sides as shown in Fig. 11. Unfortunately, when trying to parallel two delta delta together or two star star, it is not always possible to effect that by changing the external leads, but it may be necessary to alter the internal connections.

To test polyphase transformers for polarity, the procedure is very similar to that outlined for single-phase transformers. Referring to Figs. 12 and 13, A is joined to a, and a three-

checked, there should be no difficulty in applying the same procedure to any combination of poly-phase transformers. Remember polarity may be defined as the relative directions of the induced voltages with respect to corresponding terminals of a transformer.

AUSTRIAN RAILWAY ELECTRIFICATION

An extensive electrification scheme is being carried out by the Austrian federal railways, involving the conversion of about 3,600 miles of lines. Certain sections have already been completed and steady progress is being made with the construction of others. The trolley system is 15,000 volts, 16 $\frac{2}{3}$ cycles, single phase, and the energy is stepped down by transformers carried on the locomotives to a pressure suitable for the motors. Power transmission is carried out at 55,000 and 110,000 volts, and the energy is supplied principally by hydro-electric stations. Austria has abundant water power resources which make possible the electrification of such a large mileage of railways, embracing nearly all the main lines of the country. It will be several years before the scheme is complete.

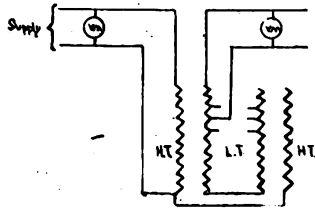


Fig 1

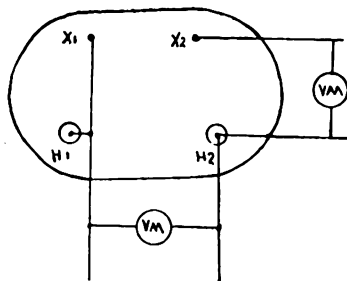


Fig 2

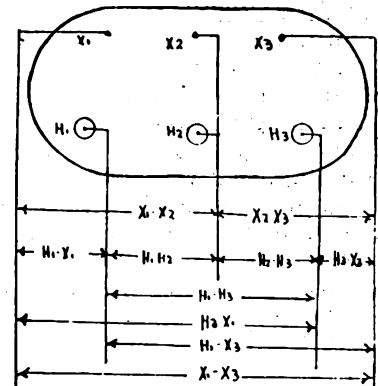


Fig 3

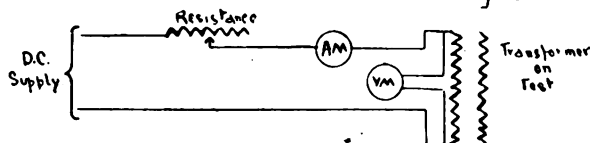


Fig 4

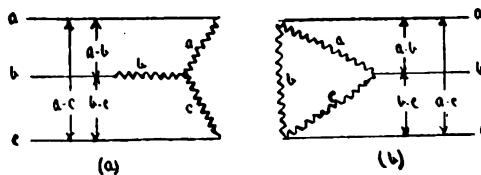


Fig 5

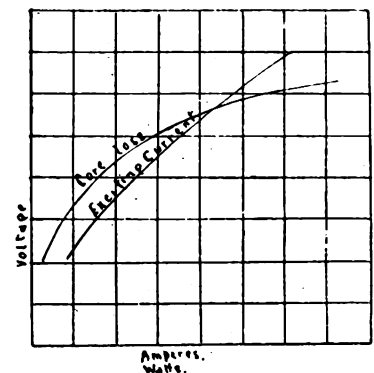


Fig 6

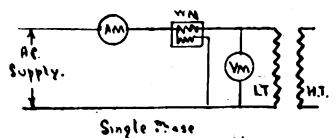


Fig 7

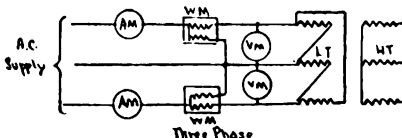


Fig 8

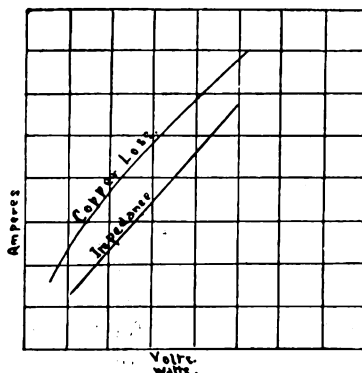
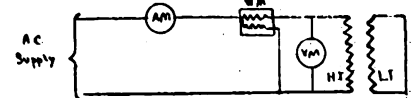


Fig 10

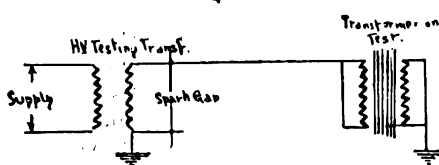


Fig 11

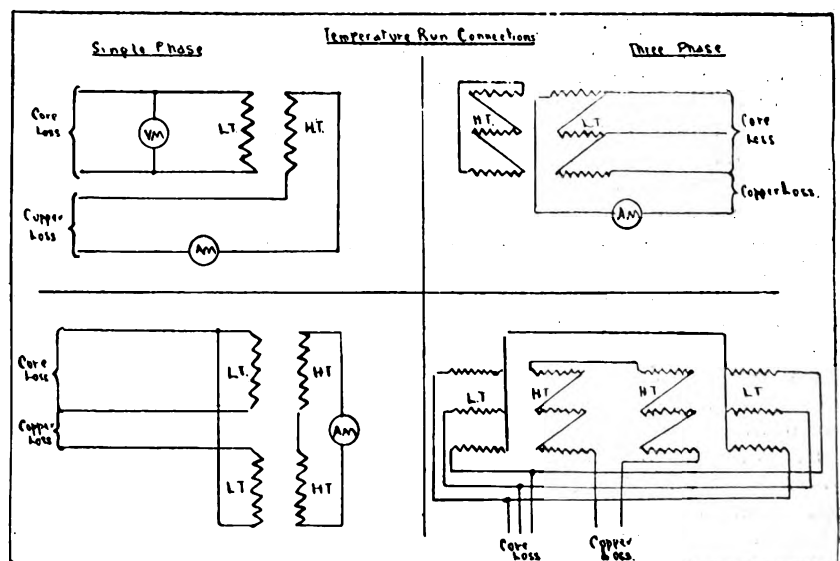


Fig 12

The Inspection and Testing of Static Transformers

By W. H. Gregory*

The main objects in testing transformers are to find out whether the manufacturers' guarantees have been met and to provide a record of the transformer characteristics. The latter is important to the operating engineer in order that he may check parallel operation with other transformers. The various tests are usually carried out at the factory, where special facilities are provided for this work. The tests are of such a nature that any defects in the material or workmanship will show up before the transformer has left the factory, so that such defects may be rectified before shipping.

Prior to the testing of the transformer, the external measurements should be checked to see if they agree with the approved outline drawing, as it is expensive to find that when the transformer has been shipped, its physical dimensions are such that it will not fit into the prepared transformer pockets. The transformer should also be inspected for leaks of oil at the gaskets of the oil valves and the welded joints of the tank; the best time to observe this is after the heat run when the oil is warm and the tank expanded with the heat. The transformer fittings such as oil gauge, thermometers, oil valves, etc., should also be checked, to see if they are those specified by the customer or the standard fittings usually supplied by the manufacturer.

It is general practice to make tests of the following characteristics in the order given, so that the transformer will be tested in the quickest possible time with the most accurate results:—

- (a) Ratio.
- (b) Polarity and phase rotation.
- (c) Resistance.
- (d) Iron loss and magnetising current.
- (e) Copper loss and impedance.
- (f) Temperature rise.
- (g) Overpotential test.
- (h) Insulation test.

Ratio Test.

This test is usually made with the transformer out of its tank, so that the various leads may be traced to their respective coils. The object of this test is to find out if the transformer has been wound correctly. Each leg of the transformer is tested separately, an alternating current being supplied to the high tension winding of sufficient value to give a good reading on the low tension voltmeter. Readings of voltages must be taken simultaneously on both high and low tension windings so that there will be no chance of a change in voltage between readings, thereby affecting the accuracy of the test (Fig. 1).

The ratio of the transformer is the ratio of high tension voltage to low tension voltage. It should be equal to the ratio of high tension turns to low tension turns, except when the transformers are compensated for internal IX drop at some specified power factor. The voltage ratio should check within one-half of one per cent of the calculated ratio. The readings obtained should be set down as follows:—

High Tension Volts input.	Low Tension Volts output	Turns Ratio	Voltage Ratio
------------------------------	-----------------------------	----------------	------------------

Polarity and Phase Rotation

The obtaining of polarity on single phase transformers is considerably easier than with three phase transformers as the question of phase rotation does not enter into consideration with single phase units. It is an easy matter to change over the external leads of single phase transformers of unlike polarity so that the angular displacement between the high and low tension windings is the same for each transformer. The A.I.E.E. standardisation rules specify that the external leads shall be distinguished from one another by marking each lead with a capital letter followed by a number, so that this method will be followed throughout.

The method of testing single phase transformers for polarity is to connect together the high and low tension terminals on one side of the transformer (Fig. 2), supply a low voltage alternating current to the high tension windings, and measure the voltage across the high tension terminals, H1-H2, and across the high and low tension terminals, H2-X2. If the voltage measured across H1-H2 is greater than across H2-X2, the polarity is subtractive, but if that across H2-X2 is greater than that across H1-H2 it is additive. The transformer should then be marked as specified in the A.I.E.E. rules.

The testing of three phase transformers to determine the polarity and phase rotation, assuming the transformer leads marked as in Fig. 3, is to connect leads H2-X2 together, supply a low voltage three phase current to terminals H1-H2-H3, and measure the voltage across the following terminals:—H1-X1, H1-X3, H3-X1, H3-X3, H1-H2-H3, X1-X2-X3. From this set of readings the polarity, phase rotation and angular displacement may be determined, assuming that the internal connections of the transformer are known.†

†See article by the writer on Polarity, Phase Rotation and Angular Displacement of Three Phase Transformers in the *Electrical Engineer*, July 15, 1924.

*Aust. General Electric Co., Melbourne.

Resistance Test

This test is important in checking up the I^2R losses, and for checking up the temperature rise of a transformer. The temperature of the windings or oil is taken during this test, and a careful record kept of same. The fall of potential method is usually used for obtaining the resistance, the source of supply being a steady direct current which can be controlled through a suitable resistance. Several readings can be obtained by varying the current in the windings from 10 to 25 per cent of full load current, resistance of both high and low tension windings being taken. If the transformer is to be given a temperature run the resistance of the winding that the test is being made on should be taken (Fig. 4). The readings obtained should be set down as follows:—

Volts	Amps.	Ohms.	Temperature deg. C.	
			Air	Windings

The resistance in ohms is obtained by means of Ohm's law.

In taking resistance measurements of three phase transformers care should be taken to note whether the windings are connected star or delta, as the resistance measured across phases a-b (Fig. 5) does not give the resistance of one phase, but the resistance of two phases in a star-connected winding, and of two phases in series and one in parallel in a delta-connected winding. It is therefore necessary to calculate the resistance for each phase as follows:—

Let r = resistance measured between phases a and b.

and R = resistance of one phase.

Then the resistance per phase in a star connected winding will equal:—

$$R = r/2,$$

and the ohms resistance per phase for a delta-connected winding will be:—

$$R = 3r/2 = 1.5r.$$

In taking resistance on the low tension side, the high tension winding should be short circuited, and vice versa, the short circuited windings helping to bring the current to a steady value quickly, which is essential when hot resistance measurements are being taken.

Iron Loss and Magnetising Current

This test is taken with the high tension winding open circuited, current being supplied to the low tension winding at normal voltage and frequency (Fig. 6). The current, voltage and watts

input are measured with suitable instruments, the readings being set down as follows:—

Single-phase readings:

Volts	Amperes	Watts	Frequency
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Three-phase readings:

Volts			Amps.		Watts		Frequency
A	B	C	A	B	C	W_1	W_2

It is considered good practice to take a curve from about 20 to 125 per cent normal voltage, the results being plotted as in Fig. 7. The magnetising current for different voltages can be seen at a glance from the curve, thus giving the engineer an idea of the magnetising current and iron loss taken by the transformer when operated on voltages above or below normal.

Copper Loss and Impedance

These two tests are carried out at the same time, the low tension winding being short circuited and full load current at normal frequency circulated through the high tension winding. The connection for this test is shown in Fig. 8. Suitable measuring instruments are connected in the circuit, volts, amperes and watts input being read, and readings tabulated as follows:—

Single-phase readings:

Volts	Amps.	Watts	Frequency	Temp.
-------	-------	-------	-----------	-------

Three-phase readings:

Volts			Amps.		Watts		Frequency	Temp.
A	B	C	A	B	C	W_1	W_2	

Wherever possible a curve should be taken of the copper loss and impedance, from about 25 per cent load current to 125 per cent load current, careful check being kept on the frequency. As the impedance volts vary directly with the frequency it will be seen that any difference in frequency will make it necessary for the reading to be corrected or retaken at the correct frequency. During this test temperature readings of air and windings should be taken and a record kept of same on test sheets. From the readings taken curves can be plotted as in Fig. 9.

Temperature Rise

It is essential when a number of transformers are bought that one or more be given a heat run, so that the purchaser may know the temperature rise at full load and other specified loads. There are several methods available for making this test, but that to be used is determined by the apparatus available at the factory.

Before commencing the temperature test the resistance of the windings should be measured, also the temperature of the oil and windings, and careful records of same kept on the test sheet. Fig. 10 gives the commonly used methods of loading one or more transformers for a temperature run, the losses being supplied either on the high or low tension winding only, or on both windings. The full load current and core loss are supplied to the transformer, and the following readings taken every hour till the temperature is constant or not more than one degree rise in one hour.

Volts	Amps.	Air	Oil		Time
			Top	Bot.	

When the engineer has satisfied himself that the temperature is constant the current supplying the losses and load can be switched off, and the resistance of the windings measured. It is essential that the same instruments be used for measuring the cold and hot resistances. The time between shut down and the measuring of resistance should be recorded, so that if necessary corrections for cooling may be made. During this test the tank and fittings should be examined for oil leaks or other defects.

Overpotential Test

This test should be made as soon after the temperature run as possible, the current being supplied at twice or two and a half times normal voltage, and at about six or seven times the rated frequency of the transformer, for one minute across the low tension winding, with the high tension open circuited. This test is to show up any defects in the insulation between the turns.

Insulation Test

This test should follow the overpotential test, the transformer being connected as in Fig. 11. The voltage applied is controlled by varying the field of the alternator supplying power to the testing transformer. The voltage should be measured between needle points or a sphere gap, the pressure being raised slowly till the gap flashes over and the voltage noted at the moment of flash over. The gap is then opened wider and the voltage raised slowly till the voltmeter reads the same as when the spark gap flashes over, and the potential held across windings to ground for one minute. This is repeated at the required test voltage for the other winding.

From the tests taken the efficiencies, regulation and temperature rise may be calculated and tabulated as shown in Table 1.

Table 1

Kv.a.	Frequency	Type	Remarks
H.T. Voltage	L.T. Voltage	Spect.	
Windings	Heat Run taken		
	Temp. Calculations made		
H.T. Amperes			
L.T. Amperes			
H.T. Resistance			
L.T. Resistance			
H.T. I ² R loss			
L.T. I ² R loss			
Total I ² R loss			
Copper loss (W.M.)			
Iron loss			
Total loss			
125 per cent Load Eff.			
100	"	"	"
75	"	"	"
50	"	"	"
25	"	"	"
Per cent Mag. Current			
"	IZ		
"	IR		
"	IX		
"	Reg. 100 per cent P.F.		
"	" 80 per cent P.F.		
Temperature Rise			
	Air		
	Water		
	Oil		
	(H.T.)		
Windings	(L.T.)		

THE COMMONWEALTH ENGINEER

An interesting article in the "Commonwealth Engineer" this month deals with the lubrication of ball and roller bearings. Although these types of bearing have greatly reduced frictional losses they have not eliminated the need for thoughtful investigation of lubrication. Indeed, they have created special problems, for in order to get the fullest efficiency and long life it is necessary for the lubricant to perform several functions. These may be briefly set out as follow:—Provision of a fluid film between the balls and the cages and race in order to eliminate the effect of microscopic roughness and reduce frictional resistance due to the sliding which is bound to occur in service; prevention of corrosion of the polished surfaces; sealing against the ingress of dust and moisture. The article discusses these functions and deals with the selection of the correct lubricants for various operating conditions.

Other articles in the same issue include: Reinforced Concrete Design with Rapid Hardening Cement Concretes; Notes on the Expansion of Pipe Bends; a discussion of Sheet Asphalte and Concrete Roads; a description of the Australian Wire Rope Works at Newcastle, and descriptions of rolling stock on the New South Wales, Western Australian, and New Zealand railways.

Electric Supply at Cairns, Queensland

By L. F. Reynolds*

The Cairns city council, North Queensland, has recognised the many advantages to be gained by a progressive community through the installation of an electric supply undertaking, and may now be considered as having one of the best equipped stations in Australia, outside those of the large power distributing corporations in the capital cities. The council has undertaken to supply power and light for all classes of consumers and also maintains its own system of street lighting.

Rapid growth has taken place since the completion of the installation. When the preliminary reports and estimates were made it was anticipated that the scheme would embrace approximately 600 consumers, and these were expected to be connected to the line somewhere about 24 months after the completion of the work. But although the supply was only switched on on Jan. 14 this year, there are already nearly 600 consumers actually connected. The council has found it necessary to install an extra seven miles of reticulation to cater for the needs of intending consumers who are recognising the benefits offered.

The power house, which is located near the centre of the town, comprises boiler room, engine room, office, workshop and store. Adequate provision has been made for extensions when necessary. The engine room plant consists of three of the latest V type Belliss and Morcom two crank compound steam engines, direct coupled on combination bed plates to alternators and excitors made by the English Electric Co. There are two 220 b.h.p. engines, each coupled to a 150-kw. alternator, and one 90 b.h.p. engine, coupled to an alternator with an output of 60 kw.; each alternator is rated at .8 power factor.

The current is generated at a pressure of 440 volts, and the supply to the outside distribution and reticulation is 415/240 volt, three phase four wire 50 cycle a.c. There are eight distribution circuits for the supply of light and power to consumers in the town, and in addition circuits for street lighting, and a high tension transmission service for the supply to the Cairns harbor board.

The boiler house equipment consists of two Babcock and Wilcox water tube boilers, each of 1,790 sq. ft. heating surface and capable of evaporating 7,080 lb. of water per hour, together with Weir feed pumps, B. & W. feed water heater, etc. Each boiler is equipped with a mechanical chain grate stoker, and B. & W. integral type superheater.

The council supplies approximately 250 b.h.p. to the Cairns harbor board in connection with the handling of sugar, and other products which come from the northern districts of Queensland. To provide a satisfactory service to the board it was considered that the minimum of loss would be sustained by the provision of a high tension transmission line. For this purpose the voltage is stepped up in the station to 5,000 volts, and carried along approximately $1\frac{3}{4}$ miles of line to a substation on the harbor board's premises, where it is stepped down again to the ordinary 415/240 voltage, for use either in power appliances or for lighting.

The original scheme for the reticulation of the town included approximately 23 miles of streets with the circuits divided up into eight groups, each being supplied from a separate switch and fuses on the main switchboard in the engine room. The street lighting comprises approximately 140 fittings ranging from 1,500 watt in the main street down to 75 watt. The circuits have been arranged in such a way that in the event of any interruption of the supply on a particular circuit in any street there will not be total darkness, as alternate lights are wired on separate circuits from the main board. This same principle has been adopted also in the main business thoroughfares where cessation of supply on one circuit cannot involve the whole of the consumers in the particular thoroughfare. Every effort has been used to make a first-class job. The poles used are of dressed ironbark throughout, those carrying the high tension line being 40 ft. long; 35 ft. poles are used in the main business parts of the town, while the balance of the reticulation has been carried out with 30 ft. poles. Owing to the peculiar nature of the ground on which the town is built special precautions have been taken in the erection of the poles to render them perfectly safe and lasting.

The rate for ordinary lighting is one shilling per unit, with special reductions to large consumers bringing it as low as 6d. The power rate is 6d. per unit for ordinary consumers, with reductions to as low as $2\frac{1}{2}$ d. for large users.

The consulting engineers for the scheme are Messrs. Christie and Reynolds of Melbourne, Sydney, and Brisbane. Their Brisbane manager, Mr. R. M. Cuthbertson, has been in charge of the details of the scheme and has supervised on behalf of the council.

*Christie and Reynolds, Consulting Engineers, Sydney.

Short Circuit Tests on a 1,200 Kv.A. Transformer

Some interesting tests were carried out recently at the works of Messrs. Ferranti Ltd., England, in order to determine the effects of a short circuit on the electrical and mechanical structure of one of the firm's transformers. The transformer was of the standard core type, 5,500/440 volts, 40 cycle three phase, and was connected delta/star, with tappings from the centres of the h.t. windings for three per cent and six per cent of normal voltage connected to a Ferranti tapping switch.

The main connections are shown in Fig. 1. The power supply was obtained from a 6,000 kw., 5,500 volt, star connected turbo-alternator, to which the high tension winding of the transformer was connected through an oil circuit-breaker. The low tension winding of the trans-

test No. 2 the generator was excited so that the voltage across the transformer only dropped to 3,000. In test No. 3 the generator voltage was increased in order to maintain full line pressure across the transformer terminals at the instant of short circuit. On this test the oscillograph curve showed that for phase A the switch closed at the maximum point in the voltage wave. The short circuit current was therefore symmetrical, and the values were as shown in Table I.

Table I.

No. of Wave	Current Crest Value in Amps.	
	First Half Wave	Second Half Wave
1	1920	1730
2	1730	1730
3	1700	1700
4	1600	1600
5	1540	1540

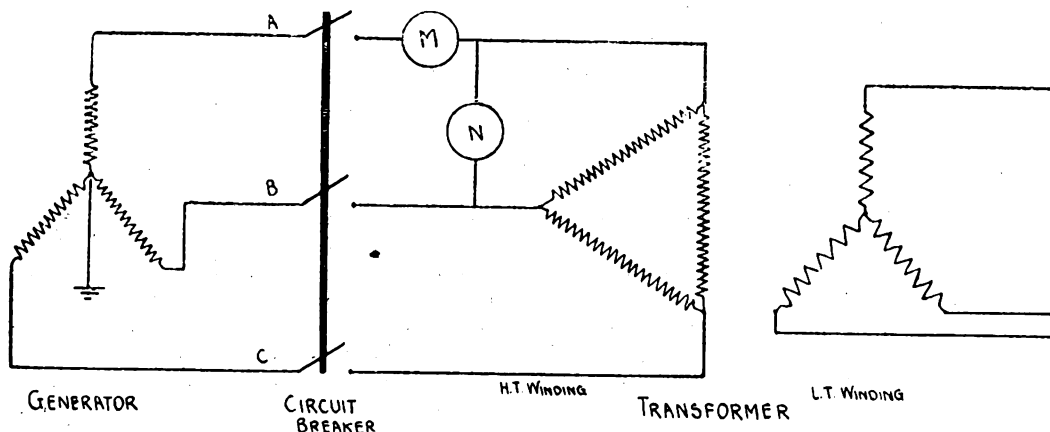


Fig. 1. Diagram of Connections for Short Circuit Test Oscillograph elements connected at M and N

former was short-circuited and the high tension tappings set for the minimum voltage, i.e., 5,170 volts, so that the full tapping range of the windings was cut out. With this tapping setting the transformer would be tested under the most severe conditions as regards short circuit forces. An oscillograph was connected in the high tension circuit, with its voltage element across the lines and its current element in phase A of the transformer. With this connection the delta connection of the transformer was unbroken. The procedure in making a test was to excite the generator for a definite voltage and close the circuit breaker, thus short circuiting the transformer until the overload release tripped the breaker.

Four tests were made. No. 1 was a preliminary test in which the generator was excited for 3,300 volts. The oscillograph curve showed that the pressure across the transformer dropped to approximately 2,400 volts, and that the line current was approximately 1,000 amps r.m.s. In

The figures in the table are taken from the oscillograph curves. The crest value of the current is given, as it is this figure which determines the maximum stress.

Test No. 4 was a repetition of test No. 3, in an endeavor to obtain an unsymmetrical short circuit on phase A. The oscillograph curve shows that the switch was closed at the zero point in the voltage wave, and that the current was almost completely unsymmetrical. The current figures are given in Table II.

Table II.

No. of Wave	Current Crest Value in Amps.	
	First Half Wave	Second Half Wave
1	3500	Zero
2	3100	400
3	2650	750
4	2300	1000
5	2000	1100
6	1800	1200
7	1500	1300
8	1350	1300

The oscillograph curves for this test are shown in Fig. 2. The thick unmarked curve shows the normal full load current to the same scale as the short circuit current.

Since the switch cannot be closed at the maximum point in the voltage wave on all three phases, the short circuit current must be unsymmetrical for one or two of the phases for all tests. For phase A the unsymmetrical short circuit occurred in No. 4 test, and the curve

forces in a transformer are proportional to the square of the current, the mechanical stresses on the windings and coil supports would therefore be 338 times the normal value.

During the tests the transformer showed no signs of stress, and there was nothing to indicate that the conditions were abnormal. Immediately after the tests it was energised at normal voltage, and showed no signs of unusual behavior. Eight days later it was removed from the tank

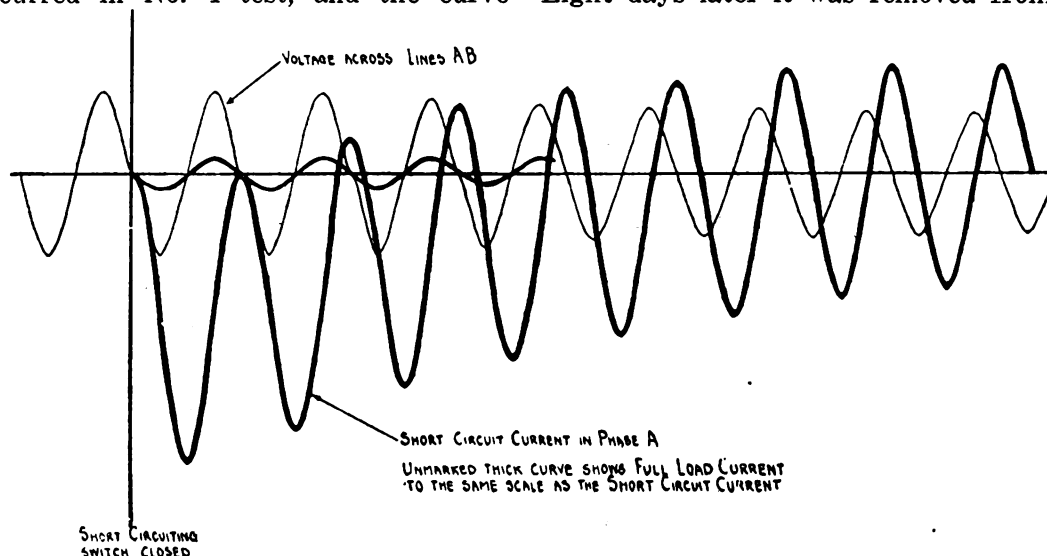


Fig. 2. Oscillograph Curves of Short Circuit Test on 1,200 kv.a. Transformer

showed that the short circuit was approximately 100 per cent displaced. Since there is no time lag effect in mechanical stresses this represents the severest short circuit conditions. The maximum instantaneous value of the current, 3,500 amps, occurred during the first half of the first wave. The normal full load crest value of the current at 5,170 volts is 190 amps, so that the actual short circuit current reached 18.4 times the normal full load value. As the mechanical

and thoroughly examined. No indication of any mechanical strain or movement of the windings, or disturbance of the structural work could be detected. This is a striking testimony to the correctness of the design and the quality of the workmanship of the transformer. Apart from this, however, the tests were of value in giving a practical demonstration of the conditions which must be allowed for in designing transformer equipment.

A Low Head Hydroelectric Development

An interesting hydroelectric installation has recently been put into operation at Ringwood on the river Avon, in England. The plant is believed to be unique in that it works on a fall of only four feet of water. The average available flow of the river is estimated at 430 cusecs. The installation comprises two 50-h.p. vertical turbines, built by Messrs. J. Armfield and Co. Ltd., each coupled, through bevel gearing to a 45-kv.a. alternator. The turbines run at 70 r.p.m., and the alternators at 500 r.p.m. The turbines are self-regulating within a three per cent speed margin between no load and full load. This excellent speed control, which is obtained by means of oil-pressure governors, is somewhat of an achievement, as the difficulties met with in the regulation of water turbines on

very low falls have rendered the utilisation of such falls for electric generation in the past almost impossible. The alternators, which with the exciters and main switchboard were supplied by the General Electric Co. Ltd., of Witton, generate at 400/230 volts, 50-cycle, three phase.

At present only the town of Ringwood is supplied, but provision has been made for stepping up for h.t. overhead transmission to the outlying districts at a later date. The total capital expenditure on the undertaking has been £19,900 to date. The estimated annual expenditure is £2,350, and the estimated revenue £3,523. The prices charged are 1/- per unit for lighting and 4d. for power. The population of Ringwood and district is 7,100, and the estimated annual consumption 23.3 kwh per head.

The Economic Value of Power Factor Correction

By H. C. Oaten*

The subject of power factor correction is receiving a great deal of attention at the present time, but not more than it should, nor more than it will receive as time goes on, for it is one of the foremost problems facing electricity authorities to-day. Especially is this true of undertakings, such as those of the New Zealand

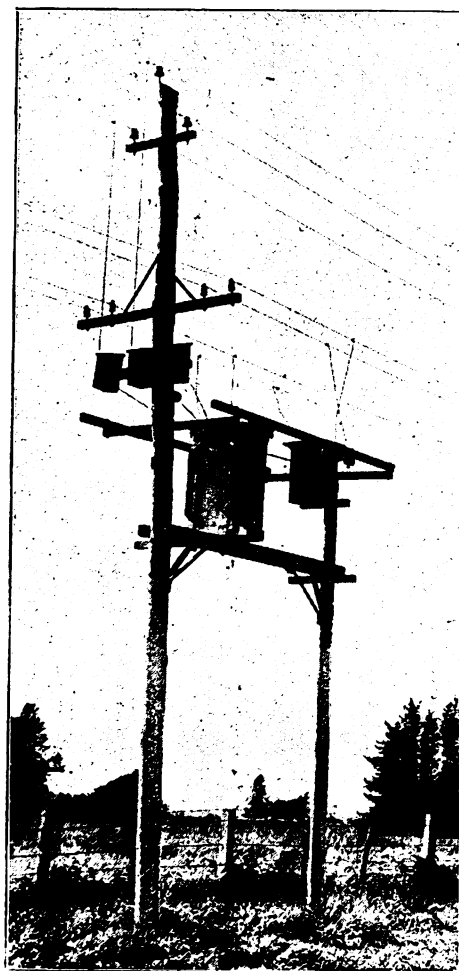
It costs just as much to buy a unit of electricity that is to be lost in transmission, as it does to buy one that is delivered to the customer, but of course the only revenue derived from the sale of power is from that which is delivered. It is surprising to know the number of engineers and managers that give this phase of the subject just a passing thought, and the number that delude themselves into thinking that they are selling cheap power. Most of them will spend any amount of money to reduce their working costs per unit, which is well and good, but there is not enough thought given to the subject of transmission losses due to low power factor.

The all-important problems at the present time seem to be the establishment of a satisfactory rate for electric power, based on the consumer's power factor, and the measurement of that power factor.

The method at present in use, mainly in the U.S.A., of penalising a consumer for a low average monthly power factor, is very unsatisfactory, as a reasonably low average monthly power factor may not be a very serious matter, to the supply authority. A low peak load power factor, however, is serious, and this applies especially to power boards in this country, who buy power on the basis of peak kv.a. (not kw.). A consumer should be penalised for low power factor during peak load hours. When some cheap method is devised for measuring and recording the daily power factor we shall be headed towards a satisfactory solution of this problem.

The general consensus of opinion of men engaged in the electrical industry in this country is that 80 per cent power factor is reasonably good, but when the fact that it requires 56 per cent more copper to transmit a given load at .8 p.f. than it does at unity p.f. is considered, the cost of low power factor may be easily estimated. Table I shows the percentage increase in the weight of copper required to transmit a given load at any power factor from unity down to .5, being based on an equal amount of copper loss in each case. The minimum losses occur at unity p.f. and the weight of copper is assumed to be 100 per cent at unity p.f. A study of the table brings out very clearly the fact that in many instances a power board would be able to earn a higher return on money invested in power factor corrective devices, than on money invested in any other manner.

There are two general methods of correcting power factor, the static condenser, and the synchronous condenser, and in comparing the two, it must be said that each has its own field of service. In cases where the load is small, say



Characteristic Application of Static Condensers to Line Transformer.

power boards, having an extensive system of distribution lines. It is the writer's desire to bring more forcibly to the mind of the engineer and manager, certain points that seem to require special emphasis, and which are along a line not being generally discussed, viz., that there is only one practical method of measuring power factor from the manager's point of view, and that is, in £ s. d. The sooner this is realised, the sooner may we expect more satisfactory results.

*Engineer, Cambridge Power Board, N.Z.

below 500 k.w., the static condenser answers the purpose satisfactorily, as, aside from improving the power factor, it will maintain an improved voltage at full load. This is very advantageous from the standpoint of good service. In addition, it requires no attention, and the internal losses are negligible, being about one-half of one per cent.

Table I.
Effect of Power Factor on Copper required

Power factor, per cent.		Copper required, per cent.
100	..	100
95	..	111
90	..	124
85	..	135
80	..	156
75	..	178
70	..	204
65	..	237
60	..	278
55	..	330
50	..	400

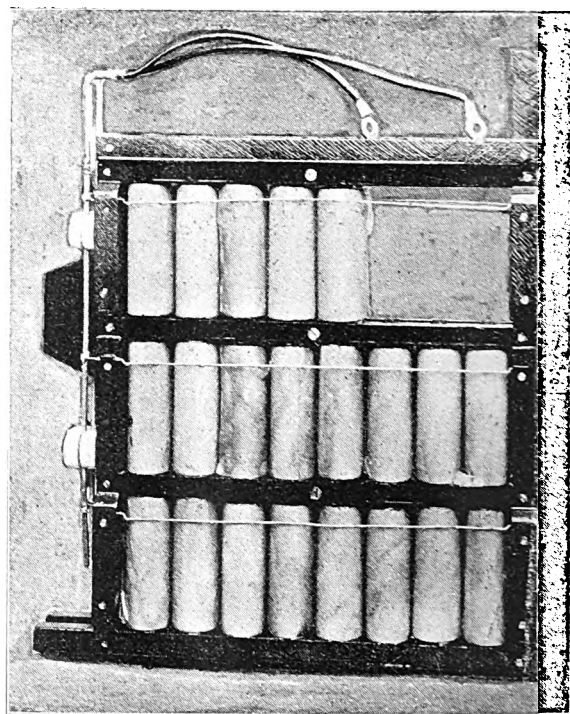
Aside from the fact that it requires heavier wires to transmit power at a low power factor, it also requires more generator capacity at the power station, and larger transformers at the substations than would otherwise be required. The maintenance of a high power factor enables savings to be made in the first cost of equipment. It is usually the case where additional plant capacity is needed, that three methods are considered, namely, increased transformer or generator capacity, increased size of wires, or increased voltage. It requires 25 per cent more generator or transformer capacity to produce the same amount of power at .8 p.f. than it does at unity p.f., and this in itself is a considerable item. The first cost of line conductors is still more important, and before any of the previously mentioned methods of increasing plant capacity are considered, the possibility of correcting the power factor should be gone into very thoroughly. In many cases, it will be found that the increase can be obtained in this way at much less cost.

Of course, unity power factor is practically impossible of attainment, and is often not desirable, but when it is known that it requires 32 per cent more copper to transmit a given load at .8 p.f. than it does at .9 p.f., the advantages to be gained by a high power factor are certainly worth striving for.

The Cambridge electric power board, N.Z., was recently faced with the following problems, in connection with its distribution system:—The transformer banks were fully loaded; the voltage at peak load periods was lower than desirable in the interests of good service, owing to the peak due to a great number of milking motors of 2 h.p. working underloaded; power was being purchased from the government on a peak load kv.a. basis, and any reduction in the peak load

would mean a correspondingly reduced power bill. Due consideration was given all factors affecting the position, and it was finally decided to install static condensers.

The condensers were 400-volt three-phase 50-cycle, manufactured by the Telegraph Condenser Co. Ltd., England, and were chosen of the low voltage because they could be placed out on the lines and on the transformer secondaries, and thus cancel the wattless currents in the transformers, distribution lines, substation transformers, and main line. The problem, in the opinion of the writer, would have been only half solved if the condensers were placed on the bus bars in the substations. Although a higher price was paid per kv.a. of condenser capacity for the lower voltage, the resulting improved line regulation has amply borne out the wisdom of the choice of the low voltage type.



Rack Holding Units Comprising One Phase of Static Condenser

The peak load before the installation of the condensers was 430 kv.a. at .8 p.f., and it was reasoned that if the power factor could be raised to .95 or higher, a saving in the power bill would be made that would, from an investment point of view, many times cover the cost of apparatus necessary to raise the power factor. As actually worked out, the results are as follows:—

Power factor before correction .8
Peak load before correction 430 kv.a. costing £3,840 p.a.
Power factor after correction .95
Peak load after correction 362 kv.a. costing £3,296 p.a.
A saving of £544 p.a.

The condensers cost erected £650, so that they will pay for themselves in 14 months, and thereafter, a saving of £500 per annum will be made. But this is not the only saving. Had the kv.a. not been reduced the transformer banks in the main substations would have had to be increased in size to carry the increasing load. The load, however, has been reduced by 68 kv.a., which will be available for new consumers without one penny outlay for additional equipment. This also applies to the distribution lines which are now relieved of wattless current, and hence are able to carry more revenue producing load. Synchronous condensers were considered, but the layout of the system precluded the use of these, unless they were automatic, as there are two distribution substations, and these are interconnected by the distribution lines. In the event of having a synchronous condenser in each sub., and one of these tripping out for any reason, the resulting disturbance might close down the system. The condensers erected number 22, and in the event of any one failing the power factor will not be noticeably altered.

Protection is afforded the condensers in the following manner:—The secondary of each distribution transformer is fused between the transformer and the line, and the condenser is connected direct to the low voltage line, so that if the condenser fails, the secondary fuse will blow and draw attention to the fault. Although the condensers are designed for 400 volts, some of them have been subjected continually to a voltage of 450 for three months or more, and show no signs of weakening. This is more in the nature of a test, since the exact voltage is never known, and line regulation may result in transient surges, so that it is comforting to know that the condensers will stand moderate overvoltage. It was thought that switching out lines would cause surges or resonance but the transformer secondaries are star connected with neutral solidly grounded so that the condenser discharges to ground. In any case, the reactance of the lines and transformer windings effectively precludes this possibility.

Philips Electric Lamp Works

Mr. A. den Hertog, a representative of the Philips Lamp Works, Eindhoven, Holland, who is on a visit to Australia, in the course of an interview with a representative of this journal, gave some interesting facts regarding the development of the industry. Within 34 years the business has grown to such an extent, that it now produces about one-seventh of the electrical lamps which are annually sold and used all over the world. Nearly all these lamps are made in one large factory and not in a combination of different factories.

In this single building, 7,500 men and women are employed making electric lamps by the most modern processes and the latest automatic machinery. A staff of more than 100 engineers, physicists and chemists superintends operations. The output is a quarter of a million lamps per day. This calls for very large quantities of glass, tungsten, packing material, etc., and in order to secure a regular supply and perfect quality it was realised that these materials should be made in their own factories.

In 1916, this consideration led to the establishment of Philips' glass works close to the lamp works. These glass works have since been extended and now comprise 12 furnaces. 1,500 men are continually engaged in blowing the bulbs and in making the huge quantities (more than 150 miles per day) of glass tubes and cane-glass, which are used in the manufacture of the

incandescent electric lamp. The proximity of these two works has stimulated a close cooperation between the scientific and technical staffs of both, resulting in important improvements in the art of glass-making, such as the white Argenta-bulbs which are now made for sizes up to 500-watt with a remarkably low absorption of light.

From the first year in which the tungsten filament was introduced, Philips' Lamp Works started a chemical department in which tungsten could be produced from the ore in that high degree of purity which is essential for the production of a lamp of long life and great mechanical strength. The wire is drawn down to 0.0004 in. for small high voltage lamps, as well as to a diameter of 0.04 in. and more for the stout spirals of big stereoptic-cinema and lighthouse lamps. Lamps of 4,000 watt, for example, are standard type for lighthouses and tests are in progress with lamps of 10,000 watt.

Large quantities of different gases are consumed in the manufacturing processes. The furnaces of the glass-works are heated by producer gas. The gas flame from a blow-pipe is the most important tool for lamp making. Many thousands of these flames, fed by town gas and compressed air or oxygen, are applied for cutting, bending, piercing and fusing the different glass parts which together form the incandescent electric lamp. Hydrogen is chiefly used for

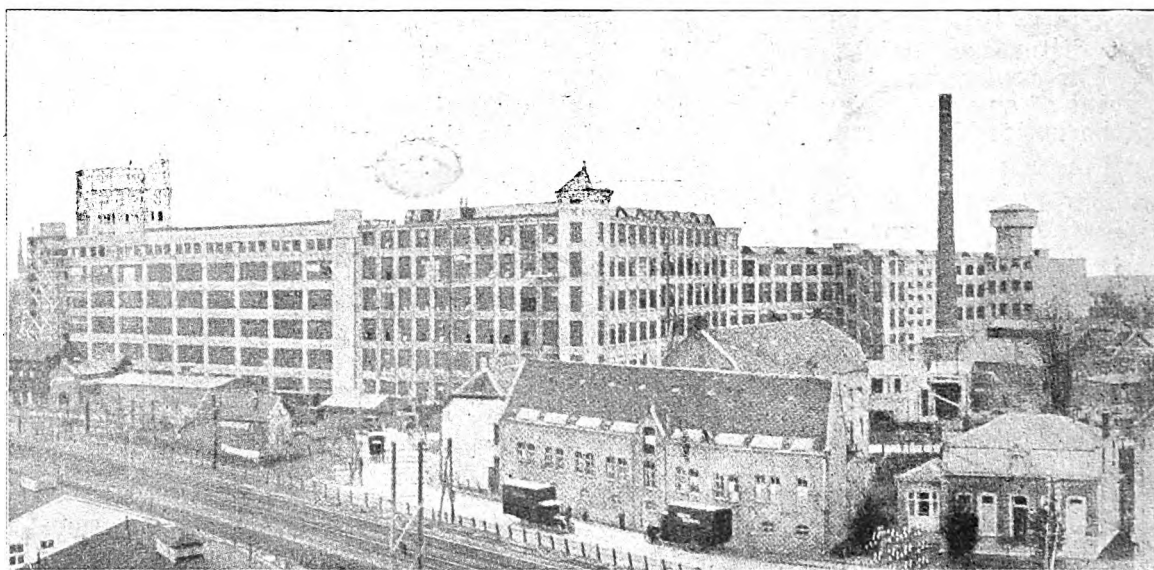
chemical purposes, viz., the reduction of tungsten oxide. This gas is produced in an electrolytic plant of 300 kw. input.

For the production of oxygen and nitrogen, a plant has been set up with a capacity of 1,200 litres of liquid air per hour. By distilling the liquid air the nitrogen is separated from the oxygen. The nitrogen is produced only for the small quantity of argon which it contains and which is fully reclaimed. The value of this rare gas, as well as that of neon, has greatly increased on account of the magnificent results which they yield in their application to electric lamps. Gas filled lamps of high quality are filled with argon, and the electric discharge in neon has recently found practical application as a source of orange red light.

library and by weekly meetings where scientists of international fame, Einstein, Langmuir, Kramers, and others have lectured. The ideas evolved in the physical laboratory are tried out at a special experimental plant, where new ideas on manufacturing processes are converted into practice and perfected until they have become ready for incorporation at the lampworks proper, as commercial successes.

Machinery

All machinery needed for the lamp works and the glass works, is made in the engineering department, which employs about 700 workmen. The automatic machinery used in different stages of manufacture is of a very intricate character. Being independent of outside suppliers, quick



Philips Incandescent Lamp Works, Eindhoven, Holland.. Total Floor Area, 613,500 sq. ft.

The power-plant has an average load of 3,000 kw. This energy is used for a total of 1,600 motors—(individual drive being applied to all automatic machine), for lighting the work and for the life-tests of lamps, as well as for the preparation of tungsten.

Scientific Research

Scientific research has resulted in remarkable improvements in the quality of the lamp, and in the development of new applications of the principles of lamp making. X-ray tubes, high-tension rectifiers and radio-valves have, during the last year, become important products of the works. Generating valves of 25 kw. (water-cooled) are now a standard product for wireless transmission installations.

A staff of scientists, physicists and chemists is engaged upon research work in a laboratory building of 30,000 sq. ft. Contact with the scientific world is maintained by a very complete

construction and perfect secrecy as to details are guaranteed. The engineering staff is in constant touch with the staff of the lamp works, enabling it to watch its own machines at work and giving every facility for testing the improvements suggested.

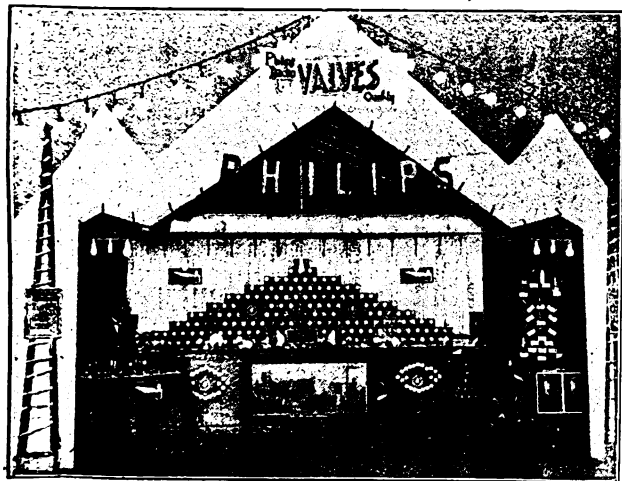
Welfare Work

Perfect machinery and careful control of the processes of manufacture do not alone secure quality. The ability and the zeal of the workers are equally important. To secure this, the management of the Philips' Lamp Works has created many institutions for the welfare of the workmen and their families.

Elementary schools and large playing grounds are provided for the children. Those boys and girls who desire to enter the works, receive special instruction on lamp-making and its requisite machinery, in a specially equipped school. Evening classes are provided to complete the education of the young men employed in the

works. These classes cover mathematics, physics, chemistry, machine-drawing, foreign languages, correspondence and accountancy. The young girls are given instruction in cooking and sewing, in addition to the ordinary curriculum.

Eindhoven being a small town, the lack of suitable houses for the rapidly increasing number of employees was met by building Philips-town, where 1,500 dwellings are leased by employees



The Philips Stand at the recent Wireless Exhibition, Melbourne

at a very moderate rent; many being purchased on very easy terms. The dwellings are constructed to give a maximum of comfort to the workmen and their families. The dwellings are equipped with gas and electricity and other modern conveniences. Careful attention was given to the lay out of the town. The streets of Philips-town offer many examples of artistic grouping of houses. There are many avenues with trees and the big sports ground forms a green centre.

Stores for the supply of groceries, bread and meat, and other necessities are run on the co-operative principle. Free medical treatment is given to all Philips' employees. Two physicians with a large staff of nurses look after the health of the workers and their families. The medical department is fully equipped with the most modern apparatus, for the treatment of sickness and accidents, and includes an X-ray installation.

Those desiring employment in the works must not only undergo a medical test, but also a test in the department of psycho-technics. By a series of simple tests for mental and physical efficiency the suitability of the candidate for a certain class of work is ascertained.

A system of copartnership has been established to interest the employees and foremen in the development of works. Part of the annual bonus is given in the form of shares. A pension-fund is provided for the widows and children of employees who are also entitled to a pension when they retire at the age of 60.

It will be readily understood that the welfare work as outlined above is a great benefit to all workers who devote their life and capabilities to the Philips' lampworks, and that it promotes the necessary good spirit between the management and the workers, as is proved by the fact that no strike has ever interrupted the regular, ever-increasing production of the works.

The result of this close cooperation between all parties and the attention paid to the welfare and comfort of the employees, in addition to the great care in the choice of raw material and the close supervision given to the various processes of manufacture, all combine to produce the quality which has made the Philips' lamp famous all over the world.

Horowhenua Power Board, N.Z.

The Horowhenua power board, which has headquarters at Levin, N.Z., reports satisfactory progress in its electric supply undertaking during the year ended Mar. 31, 1925. It is estimated that by the end of the current year the revenue will have increased to a figure that will meet the outgoing expenses. The board's reticulation consists of 105 miles of 11,000-volt lines, 167 miles at 400 volts, 50 miles for street lighting, and 36 miles of service lines. The supply to the boroughs of Otaki and Foxton is given through outdoor substations. There are 61 substations in operation, with a total capacity of 2,115 kv.a. In all cases the transformation is from 11,000 to 400 volts. All substations on the

system were constructed by the board's own staff and all the apparatus therein, with the exception of the transformers, oil switches, instruments and insulators was manufactured in the board's workshops. The aggregate motor h.p. connected is 926, the motors varying in size from one-half to 150 h.p. There is also an additional 600 h.p. applied for but not connected. The number of milking machine motors will largely increase during the next few months, as lines are now under construction in milking areas. The present number of milking motors is 94. The total number of consumers now connected to the board's lines is 1,583. Mr. T. R. Overton is engineer.

Telephone Repeaters

By F. G. Burton*

The thermionic or triode valve has been adopted by governments all over the world for long distance telephone transmission purposes, since it constitutes the finest known means of reproducing speech transmission over what have hitherto been impracticable or impossible distances. The valve incorporates sensitivity and rapidity of action, both of which are necessary owing to the high frequencies of speech currents, which range up to 2,000 periods or more per second. It also has a high amplification factor without distortion.

The telephone repeater is comprised of thermionic valves, transformers, potentiometers, condensers, and other apparatus, and every facility is provided in the mounting for variation of amplification where lines may be out of balance due to weather or any other conditions. There are two types of repeater: the line repeater and the cord circuit repeater.

Speech over long distances becomes attenuated and impeded, and the repeaters are located at points along the line route where the speech diminution is considerable. Repeaters are also mounted inside telephone exchange buildings and arranged to terminate on cords before special switchboard operators who thereby connect them on to certain long distance connections where high amplification, due to distance or line impedance, etc., is necessary. The principles of operation remain the same whether the repeater be located at points along a long distance line or in a telephone exchange building, the circuit details being, however, slightly different.

Line repeaters can be, and are used, in "tandem," i.e., more than one mounted in series more or less equally spaced throughout an extremely long or difficult route. The thermionic valve used in conjunction with a line repeater will give a maximum improvement of up to the equivalent of 20 miles of standard cable, and used in conjunction with the cord circuit repeater gives an improvement of up to the equivalent of 15 miles of standard cable.

Ringling over lines on which repeaters are in circuit is done by means of relays located in the repeater equipments, such relays being operated from the originating end and passing on the requisite alternating current to the called end. In addition, facilities are provided whereby alarms are sounded should a battery fuse blow, a valve filament break or burn out, or on failure of the ringling current or failure of battery supplies.

An idea of the plant and layout required on a long-distance route using repeater stations may be obtained from the following description of an

installation for the British post office by the General Electric Co. The repeater apparatus was manufactured at the Peel-Connor Telephone Works of the company at Coventry, England. The line in question runs from London to Bristol, a distance of 117 miles. There are two repeater stations, situated at Taplow and Marlborough respectively. These stations are identical in every particular. At present each handles 70 two-wire circuits and 25 four-wire circuits. The cable for the line contains 320 pairs of 20-lb. copper wires, paper insulated and lead covered, the overall diameter of the cable being 2½ in. It runs continuously from London to Taplow, where it is carried through the Taplow repeater station, and from thence to the Marlborough repeater station and on to Bristol where it terminates. The mileages are as follow:—London to Taplow, 27; Taplow to Marlborough, 49; Marlborough to Bristol, 41.

In addition to the actual repeater apparatus there is, of course, a great deal of subsidiary equipment, such as the filament and plate batteries and oil engine driven generators for charging purposes. The prime movers in each station comprise two horizontal, single cylinder, H type, Ruston and Hornsby crude oil engines with compressed air starting equipment. The compressed air is obtained by two Ruston air compressors, driven by G.E.C. 5 h.p. motors. The compressed air is stored in iron cylinders at 300 lb. pressure. The crude oil is stored in two 2,000 gallon tanks, located in underground chambers outside the building, and is drawn from these to the engine room by rotary pumps manufactured by Messrs. Stothbert and Pitt. The pumps are driven by G.E.C. 2½ h.p. motors from 150-volt mains.

The water-cooling system is maintained in circulation by pumps, from the engine jackets to Heenan water coolers. These pumps, together with the pans for the water coolers, are also driven by G.E.C. motors. These motors are in turn actuated from the 150/220 volt generator direct coupled to the engine, so that when the engine is started the water circulation and cooling is automatically started. Each engine is direct coupled to two generators, one being 30 volt 22/30 kw. for charging the filament batteries, and the other 150/220 volt 11 kw. for charging the plate batteries.

The battery room is large, and contains the two filament batteries, each consisting of eleven cells, having an ultimate capacity of 10,000 ampere hours. Each cell is 5 ft. 10 in. x 1 ft. 10 in. x 4 ft. There are also three 150-volt plate batteries having a capacity of 300 ampere hours. These latter also supply the lighting, the various

*Peel-Connor Telephone Works of G.E.C., England.

motors previously mentioned, and in addition the 3 h.p. motors for generating the 75-volt, 16 2/3 cycle ringing supply. The grid batteries are smaller. The "up" is 14 volt 8 ampere hours, and the "down" 18 volt, 16 ampere hours. All the batteries were supplied by the Premier Accumulator Co.

The engines, dynamos, auxiliary equipment, and batteries are located on the ground floor, and the repeater equipment is located on the first floor. The P.O. main cable is therefore brought direct up to the first floor, and is terminated on the test tablet racks. From these test tablet racks are cable runs to the transformer racks and to the distributing frame. From the latter the wires run to the repeater racks and balance racks. The power distribution

cables from the control board also run to the repeater racks. All the cable is lead covered to avoid induction troubles between the circuits. The wiring of the repeater racks is carried out with No. 20 B.R.C. wire in order to maintain a high insulation.

In addition to these stations the General Electric Co., of Witton, Eng., has carried out many repeater installations in various parts of the world. The present capacities of the stations vary from 80 two-wire circuits and 25 four-wire to five four-wire circuits. The company has carried out work in Australia where the distances between centres of population are such that efficient telephone service can only be obtained by the use of such apparatus as repeaters.

The Induction Regulator*

By T. Green†

The induction regulator is, in effect, an auto transformer. It has a primary and a secondary winding, the former connected directly across the line and the latter in series with the line. The windings are arranged in slots on a rotor and a stator respectively and in general appearance the machine is similar to an elongated induction motor. The operation may be understood by imagining a single phase shell type transformer having part of the middle leg free to revolve on a shaft. The primary winding is placed on this middle portion and the secondary on the two ends of the remaining part of the leg. Now if the axes of the two windings be in line with one another and a current flows through the primary, the flux due to this will cut all conductors in the secondary and in consequence a maximum voltage will be induced. Suppose the primary to be revolved about its shaft through a small angle, then the axes of the coils will not be in line and a lower voltage will be induced in the secondary. This diminution of voltage goes on until the angle between the two axes is 90 deg., when no e.m.f. will be induced. On moving the primary through another 90 deg. the voltage will again rise to a maximum value, but this time it will have an opposite sense. If the secondary winding is in series with the line, the line voltage will be subjected to a change.

Construction

In principle the regulator works on these lines but the construction is more elaborate. The rotor, carrying the primary winding, is capable of movement through an angle of 180 deg. and is actuated by means of suitable gearing. It may

be moved either by hand or by automatic motor drive. The gearing is of the self-locking type so as to resist the tendency to movement due to the pull between rotor and stator. A worm drive is usually employed and the ratio between the regulator rotor and the actuating mechanism is in the vicinity of 300 : 1. When the regulator is motor driven a limit switch is arranged so that the operating circuit will be opened when the rotor comes to either end of its travel. A brake is used to ensure the movement of the rotor being dead beat. The shunt winding, sometimes called the excitation winding, is placed on the rotor, and the series or secondary winding on the stator. Single phase and polyphase regulators differ somewhat, both in the arrangement of windings and the principle of action.

In the single phase regulator in addition to the excitation winding on the rotor there is a short circuited winding, called a tertiary winding, which has its axis at right angles to that of the excitation winding. Its function is to equalise the losses and reactance of the regulator in its various positions of buck and boost. When the rotor is in the maximum buck or boost position the effect of the tertiary winding is zero. When the rotor is in the neutral position, however, the tertiary winding has a maximum effect, which is to balance the ampere turns of the series winding, and thus prevent the regulator from acting as a choke to the line voltage. In the full buck or boost position the excitation winding itself performs this function and in the intermediate positions the two windings act in conjunction.

The polyphase regulator is arranged differently to the single phase inasmuch as it has no tertiary winding and there are extra phase

*Extract from Paper read before the Electrical Engineers' Association, Sydney Technical College.

†Testing Department, Sydney City Council Electric Supply.

windings both on the rotor and stator. The rotor winding is identical with that of the stator, there being one shunt winding and one series winding per phase. The windings are so arranged that the circumferential length of each phase on the stator closely approximates the span taken by the corresponding phase on the rotor. If a polyphase current be supplied to the rotor, the field set up will rotate. It will have at all times a constant value and will induce in the series windings a constant e.m.f. Now since the series windings are identical with those on the rotor, there will be a rotating field set up when a current flows in them. Both these fields rotate in the same direction. Since both the excitation and series current are from the same supply it follows that the frequency in both cases is the same and the two rotating fields run in synchronism. It is here that the principal difference between the single phase and polyphase regulators is apparent. In the case of the single phase regulator different values of e.m.f. are induced in the series winding at different positions of the rotor, but with the polyphase regulator the voltage induced at all times in the series windings is the same, no matter what the position of the rotor may be.

The variation of line voltage in the polyphase case may be conveniently explained by considering the two phase regulator and its behavior. This regulator will have two pairs of poles on both the rotor and stator. When the windings are moved so that the axis of each phase winding on the rotor is in line with the corresponding axis of the same phase on the stator, the constant voltage induced in the stator windings will be directly added to or subtracted from the line voltage. This is similar to the single phase case. Suppose now that the relative positions of the rotor and stator be altered, making the rotor move, say, 45 deg. (mech.) ahead of its late position. In this case the two rotating fields will still move at the same speed but the stator field will lag 45 deg. all the time. The voltage induced will be the same as before, but it will be induced in another phase and its phase relation will not be the same as the phase of the induced e.m.f., in fact, the phase difference is 45 deg. Then if this constant induced voltage be added vectorially at an angle of 45 deg. to the generator voltage, we will obtain as a resultant a new line voltage. By continuing to move the rotor thus, new phase relationships are set up until, when 180 deg. have been moved through, direct addition and subtraction is again arrived at, but in the opposite sense to that in the original position.

Testing

The tests necessary in order to check the performance of an induction regulator are as follow:—Cold resistance, ratio, polarity, core loss and exciting current, impedance, noise, pressure test, and test of auxiliaries.

(1). Cold resistance is taken of all phases and parallel circuits by the drop in potential method. The temperature of oil and windings should be the same as the ambient and the current strength should be just sufficiently low to insure good readings and not increase the temperature of the windings. For this reason, readings must be taken quickly. A correction of the resistances is made so as to compare them with the resistance at specification temperature.

2. Ratio.—The regulator excitation is connected to a supply similar to the one on which it has to work. Voltage readings are taken over each series winding. In the case of a single phase regulator the induced volts will be the same at two points as is expected, namely, the full buck and boost positions. At the neutral position the voltage induced will be nil. For polyphase regulators the voltage read on each series line will be constant for all positions of the rotor. If the windings of this particular type of regulator are connected incorrectly the resultant voltage across phases will be unbalanced.

3. Polarity.—This is really a check on the indicating plate to see whether the directions indicated for buck and boost are correct.

4. Core loss.—This is carried out with the supply on which the regulator is to work. The magnetising current for all positions of the rotor should be practically constant. The ends of the series windings are isolated in this test. The core loss in a polyphase regulator is greater than in a single phase on account of the rotating field which increases the hystereses and eddy current losses.

5. Impedance.—In this test the series windings are shorted through a current transformer or ammeter and the excitation voltage is increased gradually until the voltage induced in the series windings is sufficient to force full load current through them as read on the ammeter. In the polyphase regulator either the excitation or series windings may be shorted and the current supplied from the other side, but in the case of the single phase type, only the primary winding may be shorted because of the already shorted winding on the rotor.

6. Noise.—The principal causes of noise are: Uneven air gap; loose fitting of rotor in its bearings; natural frequency of vibration. The uneven air gap will give rise to a greater flux density at the point where the rotor and stator are closest. The magnetic pull being proportional to the sq. of the flux density, the pull at the point of small air gap will be much larger than at other places and it may be so bad as to spring the shaft so that the rotor may touch the stator. An uneven air gap will also result from loose bearings causing effects similar to the first case. The natural frequency of vibration of both the rotor and stator have to be such, that they differ from the frequency of the

supply and from one another. If this be properly arranged, a state of resonance is eliminated, as is the noise following therefrom. The construction of all parts should be rigid so as to minimise vibration.

The test for noise consists in moving the rotor through its full distance while its excitation is normal and the line current at a maximum. If the noise appears too loud, the rotor shaft and bearings should be refitted.

7. High Potential.—This test is generally known as a pressure test. If the regulator is of the high tension type, the pressure supplied to the windings is usually two and a quarter times the ordinary working pressure, plus 2,000 volts. The method adopted is to join all stator windings to the active side of a testing transformer and the rotor windings to frame and earth. The pressure is left on for one minute and then gradually reduced to zero. The rotor is then tested to earth in a similar way.

Applications

The use of induction regulators for the control of the voltage of lighting feeders is compulsory in some parts of the world. The substations to which high voltage is supplied have feeder regulators on the low voltage side which keep all consumers round the substation as centre supplied at a uniform voltage. In some cases regulators are installed out of doors on poles. Large consumers of power and also lighting usually

take their lighting supply from the same lines as their power. Any fluctuation in the power load is shown up on the lighting, but by installing a regulator in the lighting circuit, the voltage may be maintained constant. Amongst further applications are the control of the voltage of supply to induction motors and the control of supply to furnaces for hardening and annealing, where a steady pressure is essential. For electro-chemical applications regulators have been made with a carrying capacity of 10,000 amps. at a range from 83 to 237 volts.

Some regulators for miscellaneous applications are made having 100 per cent regulation. This means that when the rotor is in the maximum buck position, the induced voltage is exactly equal and opposite to the line voltage so that there is zero voltage at the load end. By moving the rotor, the line voltage gradually predominates until the neutral is reached, where there is full line voltage straight through the series windings. Any further movement of the rotor has the effect of increasing the line voltage until it becomes double. These types of regulators are of great value to a testing department where variable a.c. voltages are required. For pressure testing of high voltage transformers, the single phase regulator of this type is almost indispensable, for the gradual increase of voltage is absolutely necessary, as well as the gradual decrease if the specimen under test does not puncture.

Equipment for Sydney Railway Electrification

The rolling stock equipment to be supplied by the Metropolitan-Vickers Electrical Co. for the Sydney railway electrification comprises motors, control gear, and all auxiliary apparatus for 150 motor cars and 150 trailers. Multiple unit control is to be used and the coaches will be made up into two, four, six and eight car trains. The requirements are: 108 motor coaches with driving cabs and 42 without, and 146 trailers without driving cabs and four with cabs. The line voltage will be 1,500 d.c. and two-motor equipments are to be used on each power car. These equipments consist of two 360-h.p., 1,500-volt motors arranged for series-parallel control. The weight of each train unit, i.e., motor car and trailer, will be 92 tons when crush loaded with passengers, and the balancing speed will be 50 m.p.h. It is believed that the motor coaches will have the largest h.p. per axle that has yet been used on any multiple unit train.

The design of the motors includes a new feature which has already been tried out in practice and proved satisfactory. This consists of making the armature slots with tapered sides. It has been found that by making the tooth parallel sided and tapering the slot, quite an appreciable increase in output for the same size

armature is possible. Special strip is used for the armature coils and a new process of bakelising the armature coils at different stages of their manufacture is used. All the insulation consists of mica and asbestos. The motors are self-ventilated with a fan fixed to the motor shaft, the air being drawn over the windings. They are also fitted with commutating poles. The control is electro-pneumatic by means of a small master controller.

Current for the master controller and for train lighting is to be supplied by a motor generator and floating battery. The motor generator takes current from the trolley wire and steps it down to 32 volts. The machine is self-ventilated, but is so designed that the ventilating air does not come into contact with the windings but passes through the iron parts of the frame and armature only. This prevents any danger of dirt accumulating on the winding or commutators and causing a breakdown. A special patent automatic voltage regulator is used in connection with the motor-generator. A large portion of this electrification equipment is to be manufactured at the works of Metropolitan-Vickers Australia Pty. Ltd., Sydney.

Lubrication for Small Motors

Fractional horse power motors are very extensively used in situations where expert attention, or even ordinary inspection is seldom given. Thus it is essential that they be thoroughly reliable in all details, so that satisfactory service may be given in spite of neglect. A point of design that requires particular care in order to ensure this reliability is that of providing lubrication that will function properly for long periods without attention. Special interest, therefore, attaches to an announcement by the Century Electric Co., of U.S.A., of the development of a system of small motor lubrication which assures the user of continuous 24-hour per day service over a period of years without re-oiling. The

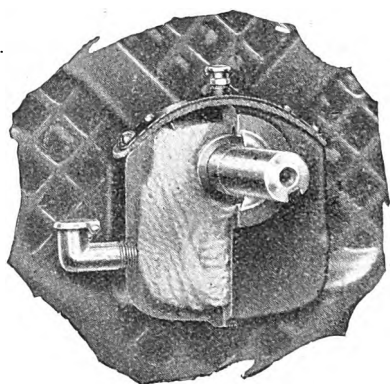


Fig. 1. Cut-away section showing motor bearing with wool yarn system of lubrication.

system depends for its effectiveness on the use of a number of continuous strands of pure wool yarn introduced into the bearing housing and oil well in such a manner as to replace the present methods of carrying oil to the shaft surface.

Fig. 1 shows how the continuous strands of wool yarn are packed into the oil well so as to comfortably fill it, and are in direct contact with the surface of the armature shaft. Constant contact of the wool yarn with the shaft surface is assured by a spring attached to the underside of the oil well cover, so arranged that it exerts a downward pressure against the wool. As is well known, pure wool yarn has a high absorption factor, with the result that when the lubricant is introduced into the oil well, the wool yarn immediately absorbs and holds in suspension a very large volume of the lubricant. It is claimed that the wool yarn used in this newly developed type of lubrication will in itself hold sufficient oil in suspension to properly lubricate a small motor for at least one year's continuous 24-hour-per-day operation.

Aside from the oil held in suspension by the yarn, there is, of course, an additional supply in the well. Since the strands of wool yarn are continuous, they allow capillary action to assert itself so that the lubricant is continuously delivered to the armature shaft, with the result that the shaft constantly rides against a fully saturated bundle of wool yarn strands. Since the capillary action of these strands of pure

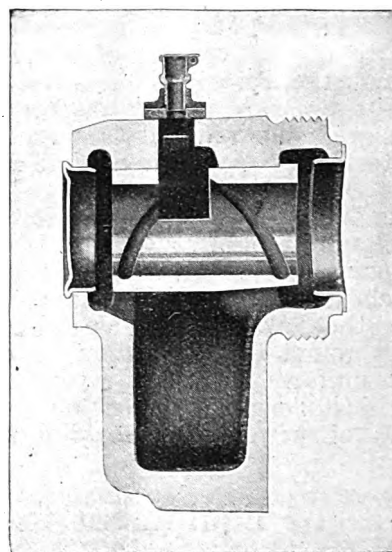


Fig. 2. Cross section showing bearing and oil well construction

wool yarn is very pronounced, it follows that a new supply of oil is being constantly delivered to the shaft. Consequently all the oil is being filtered by being passed through the yarn fibre.

Aside from these features, it is claimed that in thousands of cases of regular service this new lubrication system has proved unexcelled, even where heavy bearing pressures are encountered. It is further claimed that the system eliminates all tendency of oil bubbling, and the possibility of clogging up the returns to the oil well. Further, that it assures proper lubrication under all conditions even at low temperatures.

CONCRETE POLES IN NEW ZEALAND

The Waitomo electric power board has decided to use concrete poles for its reticulation work, making the poles sufficiently strong to allow for an increased weight of wires as settlement and current consumption increases. The Taranaki power board states that it has manufactured 2,740 concrete poles at an average cost, including plant, of £3/12/-, and that the poles are thoroughly successful.

A New Hecla Electric Stove

As a result of experience in the manufacture of electric cooking apparatus, coupled with close study of the requirements of the domestic electric field, Hecla Electric Ltd., of Melbourne, has been enabled to put on the market a new stove incorporating many desirable features. The design is based on sound electrical and mechanical principles, and the workmanship is of the first grade. The oven is constructed of heavy gauge sheet steel to internal dimensions of $16\frac{1}{2}$ in. x 13 in. x $10\frac{1}{2}$ in., which gives ample capacity for the needs of a family of about six adults. It is encased on all sides with a $1\frac{1}{4}$ in. thick asbestos jacket. The top of the stove carries



The New Hecla Stove.

the hotplates; each is controlled by its own three-heat switch on the front of the stove. The hotplates sit in a metal bowl which is packed with asbestos. This serves to prevent loss of heat through the under-side of each plate. The stove is mounted on four cast legs, the front pair being nickel-plated and polished. Practically the whole of the front is finished in polished nickel, while the sides and back are finished in eggshell-gloss black. The interior is finished with applied aluminium.

The oven has top and bottom heating units, each separately controlled by its own three-heat switch, giving a very wide range of heat regulation. The top unit is of the open type, suitable for grilling and toasting operations, and is protected against mechanical injury by a coppered

iron guard. The element itself is of spiralled nichrome, suspended on moisture-proof porcelain links, and covers practically the whole area of the upper surface, thus ensuring an even distribution of heat. The bottom unit is similar to the top one, except that it is protected against spilling as well as mechanical injury by means of a steel plate which entirely covers its upper surface, yet leaves the sides open for the circulation of convection currents.

The hotplates consist of an upper and lower casting between which is bolted a ring unit. The ring unit is claimed to have many advantages. The ring consists of an element of nichrome ribbon wound on edge and insulated from its rustproof metal casing with a special cement, which is put in under heavy hydraulic pressure. This cement is moisture proof and has high electrical insulating properties, yet is a good conductor of heat. The unit thus formed is a compact body, metal encased, which is at once light and practically non-destructible. The heating element itself, being enclosed in cement, is excluded from contact with air, and is thus non-oxidisable. These ring units are clamped between two cast-iron plates suitably recessed, and will withstand constant use, and even abuse, without the slightest deterioration. They can be operated at temperatures up to 1,400 deg. F. without danger of destroying the element or terminals, and the insulation will withstand a pressure of 1,100 volts to earth without damage. Units of this type are made in capacities from 500 to 1,800 watts, and in sizes from 4 in. to 11 in. diameter.

All interior wiring in the stove is done with heavy gauge copper asbestos insulated wire, and all holes in the metal where wires pass through are bushed with vitrified porcelain bushes. Every unit has its own switch, suitably named with a neat brass nameplate. The switches are of a larger size than need actually be used and are of the latest reciprocating type. Each unit has its own fuse, also suitably nameplated. The fuses are easily accessible, and are of the D. and S. enclosed pattern. They are protected from accidental contact through spilling, by a metal water shed.

The accessories supplied with each stove are: Grilling pan and handle, grilling grid, baking dish, scone tray, and wire tray. A written guarantee for twelve months is given with each equipment. The prices range from £16 for the stove without hotplates to £24/17/6 for a stove with one 1,200-watt and two 880-watt plates.

MELBOURNE CITY COUNCIL ELECTRIC SUPPLY

The report of the electric supply committee of the Melbourne city council for the year ended December 31, 1924, discloses a steady expansion in the activities of the undertaking and a sound financial position. The committee now has control of street lighting in the city and is effecting many improvements, the principal one of which is the new scheme for St. Kilda road. On the expiry of the franchise of the Melbourne Hydraulic Power Co., its undertaking was handed over also to the control of the committee. Mr. W. H. Alabaster, the city electrical engineer, is particularly interested in the use of electricity for cooking. His department has a showroom and conducts demonstrations of electrical cooking with a view to familiarising the public with its advantages.

The principal source of the council's power supply is its steam generating station at Spencer street, the total capacity of which is 19,800 kw. This was supplemented during the year under review by a bulk supply of 10,000 kw. purchased from the electricity commission. In addition there is a battery of 1,200 kw. capacity at the Heffernan lane substation. Statistics of the operation of the undertaking are as follow:—

Plant capacity	31,000 kw.
Maximum demand	28,100 kw.
Load factor	31.99 p.c.
Units generated	19,993,000
Units purchased	58,772,800
Units sold—	
Private lighting	15,611,727
Power and heating	29,554,103
Bulk supplies	17,090,063
Municipal bldgs.—Light	483,606
Street lighting	2,752,309
Total	65,491,808
Connections—	
Lighting	17,549 kw.
Power and heating	51,541 "
Bulk supplies	4,231 "
Municipal bldgs.—Light	350 "
Street lighting	589 "
Total	74,260 "
Motor connections—	
Number	6,162
H.p.	37,392
Revenue—	
Private lighting	£196,463
Power and heating	170,119
Bulk supplies	74,110
Meter rents, etc.	1,832
Public lighting	13,818
Rent of premises, etc.	1,965
Total	458,307
Working costs—	
Purchase of energy	108,615
Generation	78,611
Repairs and maintenance	20,456
Distribution	31,012
Management	26,080
Total	264,774

Capital charges—	
Sinking fund and depreciation	£70,456
Interest	38,298
Loan flotation	1,091
Street lighting and lamp renewals	16,852
Total expenditure	391,471
Net profit	66,836
Revenue per unit sold—	
Private lighting	3.02d.
Power and heating	1.381 "
Total private supply	1.706 "
Total overall	1.679 "
Cost per unit sold—	
Generation	.761 "
Distribution	.114 "
Management	.095 "
Capital	.403 "
Street lighting, etc.	.062 "
Total overall	1.435 "
Capital expenditure during year—	
Mains	£75,615
Machinery	22,086
Sub-stations and transformers	14,603
Switchboards	10,926
Meters	10,821
Original cost of plant in use	1,503,528

STATISTICS OF LARGE AMERICAN ELECTRICAL UNDERTAKINGS

"The Electrical World" has published two interesting tables of data concerning all the generating and distributing undertakings in the United States and Canada that have an annual output of over 100,000,000 kilowatts of energy. The statistics cover lighting, power and railway companies and the concerns listed number 122. Table I compares the yearly output and peak load of these undertakings for each year from 1915 to 1924. The growth of the use of electricity is indicated by the fact that the 1915 list only gives 29 stations of sufficient output to be noted. The leader for the United States in the year 1924 was the Niagara Falls Power Co. with an output of 2,858,482,674 units. In Canada the hydroelectric power commission of Ontario was responsible for an output of 3,026,615,156 units amongst its various undertakings. The largest output of a railway company was that of the Interborough Rapid Transit Co. at 1,019,620,637 units. Table II gives more detailed information comparing the years 1923 and 1924 in regard to generated output, purchased output, distribution for light, power, railways, etc. This shows that in the particular instances above mentioned the outputs were obtained as follow:—The Niagara Falls Power Co. generated in a plant of 600,090 kv.a. capacity; the hydroelectric power commission used steam plant of 15,000 kv.a. capacity and hydroelectric plant of 730,092 kv.a., and purchased 135,834,505 units; and the Interborough Rapid Transit Co. used steam plant of 390,000 kv.a. capacity, and purchased 32,027 units. The largest aggregation of generating plant under single control is that operated by the Edison United Companies, New York, totalling 841,000 kv.a. of steam plant. The output of this organisation is 2,056,432,473 units.

A New Fairbanks-Morse Crude Oil Engine

A Diesel engine, known as the type Y and operating under a compression of 500 lb., has been placed on the market by Fairbanks, Morse and Co. This unit replaces the company's former type Y, which was a lower-compression machine. The engine is built in ratings of 37½ h.p. and 50 h.p., running at 300 and 257 r.p.m. respectively, for the single unit with multiples of these units for multi-cylinder machines. Tests made on this machine are said to show a fuel consumption of 0.42 lb. of 18,000 B.t.u. fuel oil per b.h.p. at full rated load.

The fuel-injection system is of the same general design as that used in the former engine with the exception that the pumps are grouped on a pump deck and enclosed in a case which serves as a fuel-oil reservoir. This change in design eliminates suction piping and permits of the fuel pumps being constantly submerged. The fuel-injection system, governor and the complete control of the engine centres in a unit mounted at the end of the engine. The lubricating system is entirely automatic and consists of a double lubricating oil pump and an outside filter.

The new engine, like its predecessor, is of the two cycle port-scavenging type, but the use of the higher compression has introduced improvements. The principal resultant advantage is that the engine starts cold, without the use of a heating torch. At the head of the cylinder is a spherical combustion chamber in which the scavenging air is entrapped on the compression stroke of the piston. The final pressure of 500 lb. per sq. in. corresponds to a temperature around 1,000 deg. F. A few degrees before the top dead centre is reached a spray of fuel is injected into the chamber through an axially placed nozzle. The heat causes slow combustion to take place, burning the charge, mainly to form carbon monoxide. As the piston recedes on the down stroke the gases rush through the neck of the combustion chamber into the cylinder space, producing a considerable amount of turbulence which thoroughly mixes the carbon monoxide with the excess air. The final combustion then takes place, converting the mixture to carbon dioxide. Over 50 per cent of the heat due to the entire combustion is liberated in the latter stage, but owing to the fact that the piston is now beginning to pick up considerable speed the expansion neutralises any rise in pressure which might occur, thus giving the engine a true Diesel characteristic.

Careful attention has been paid to mechanical details in the design of this new Y engine. One interesting point is that the fuel injection pumps for all the cylinders of a multi-cylinder engine are operated by the one cam. This ensures

identical injection characteristics for all cylinders. The starting valve plungers are also operated from a single cam. The whole design is rugged and the new units should be quite as reliable as the old. The manufacturers have built upon 30 years of experience, during which period over three million h.p. of internal combustion engines have been turned out.

ELECTRIC LIGHT AND POWER SUPPLY CORPORATION

The directors of the Electric Light and Power Supply Corporation Ltd., which operates an electric supply undertaking with a power station at Balmain, Sydney, have presented their report for the year ended April 30, 1925. The total number of consumers at the end of the period was 17,311, an increase for the twelve months of 2,279. The expenditure during the year on machinery, buildings, etc., amounted to £52,086. The revenue totalled £167,593, and the working costs £84,951. Interest on debentures amounted to £229, depreciation and reserve £18,900, and provision for income tax £10,000. An interim dividend, paid on December 8, 1924, amounted to £25,638, and £27,875 was carried to the balance sheet. The issue of 150,000 new shares in July last was considerably over subscribed. Mr. J. E. Donoghue is general manager and chief engineer.

JACKADGERY HYDROELECTRIC SCHEME

The proposed county district which will be included in the reticulation from the Jackadgery hydroelectric scheme, in New South Wales, now consists of a compact area, controlled by 30 local governing bodies. It includes 14 municipalities and 16 shires, whose areas cover about 14,000 sq. miles, with a population of about 125,000, and an unimproved capital value of upwards of £18,000,000. The formal application for the proclamation of the county district is before the local government department.

The withdrawal of the Armidale municipal council from the scheme was due to the fact that the surrounding shires of Dumaresque and Guyra would not be included. This left Armidale in an isolated position and prejudiced the chances of obtaining bulk supply at the uniform flat rate. The withdrawal was made at the suggestion of the joint electricity committee which is arranging for the formation of the county council. The Armidale council wishes it placed on record that it was willing to form one of the constituent bodies at the inception of the scheme, and that if circumstances permit it will be willing to join up again in the future.

Radio News

A new studio has been equipped at Mr. E. J. Hume's station, 5DN, Adelaide, and a daily broadcasting service will be inaugurated shortly.

Tenders have recently been invited for the purchase of the assets of two Melbourne radio dealers, Messrs. Powell and Butler, trading as the Pacific Radio Co., and the Crystal Clear Radio Co.

Two-way wireless telephone communication by means of duplex receiving and sending sets has been accomplished between ships at sea 150 miles apart. Each set operates on two wave lengths, thus overcoming interference between sending and receiving.

Keith Stokes Pty. Ltd. has been registered with authorised capital of £5,000 to trade as wholesale merchants in wireless telegraphic and telephonic goods, etc. First directors are: R. R. and E. G. Stokes, and the registered office is in Sydney.

An additional "B" wireless broadcasting station license has been granted by the Postmaster General's Department, Sydney. The applicants, the Burgin Broadcasting Service, 340 Kent street, have been allotted the prefix 2BE, and a wave-length of 314 metres. At present the company is working on a transmitting power of 60 watts.

The MacMillan polar expedition, which recently left to carry out extensive explorations, is equipped with radio apparatus which, it is hoped, will enable it to keep in constant touch with civilisation. The wireless operator is the accomplished amateur, Mr. John Reinartz. Wave lengths of 20, 40, 80 and 160 metres are to be used according to conditions.

On Wednesday, June 17, 1925, in conjunction with a wireless concert arranged by Farmers (2FC), and held at the Sydney town hall, Madame Elsa Stralia was broadcasted for the first time. The British General Electric Co. Ltd. seized the opportunity to display the advantages of the Gecophone receiving set before an audience of critics and wireless experts at its show-rooms in Sydney. The equipment included a five-valve set, to which was attached four Gecophone loud speakers in series. The circuit embodied a radio frequency stage, a detector, and two stages of resistance-capacity coupled audio frequency amplification, with the fifth valve choke-coupled. A loop aerial was used. The demonstration proved highly successful, all the richness and delicate shading of the notes being faithfully reproduced.

Mention was made in the April number of the "Electrical Engineer" of a case where the postal department launched a prosecution against a person for manufacturing wireless sets without having a dealer's license. The police magistrate before whom the case was heard dismissed the information. The Commonwealth authorities thereupon lodged an appeal, but this also has been dismissed by the High Court.

The number of licenses granted in the various states under the wireless regulations are as follows:—New South Wales, 33,964; Victoria, 19,481; Queensland, 1,211; South Australia, 2,895; Western Australia, 3,427; Tasmania, 540. £113,658 has been collected in license fees. The amounts paid to the various broadcasting companies are as follow:—2FC, £34,629; 2BL, £12,018; 3LO, £14,444; 3AR, £4,090; 6WF, £4,220.

For the year ended Mar. 25 last, the British Broadcasting Co. had an excess of revenue over expenditure of £85,000, after making all the usual provisions including £10,000 for the staff provident fund. The dividend, which may not exceed 7½ per cent annually, absorbs £5,200. The balance will be carried forward. The report states the surplus is only a paper one, since £59,000 so far has been utilised in the construction and expansion of stations, and further provision is necessary in that connection.

HIGH CLASS RADIO EQUIPMENT

The excellent quality of McMichael radio apparatus, which was exhibited at the recent wireless exhibition in Melbourne by Osboldstone and Co., should make it attractive to listener-in and experimenter alike. The manufacturers, L. McMichael Ltd., of London, are specialists in their work and turn out products of high efficiency and thorough reliability. In addition, the finish of all parts is such as to attract attention, while the prices are reasonable.

A good range of broadcast receivers of very pleasing appearance and undoubted efficiency is manufactured. Of these the three valve is the most flexible, as it can be coupled in a variety of ways by the use of various McMichael attachments. A feature of the sets is the bringing out of terminals on to the panel face in order to facilitate changing of the coupling arrangements. The reception range is from 350 to 1,000 metres with a 100 ft. aerial. Higher ranges can be obtained by the use of extension sockets which are provided for the reception of coils.

The home assembly line makes a strong appeal to the amateur with a taste for construction but little spare time. Panels, case and all parts are supplied for making up one, two, three and four valve receivers and a two valve amplifier. An interior view and wiring diagram is supplied with each set of parts. Amongst the McMichael

accessories are many of unique design or layout, the result of painstaking research in the endeavor to evolve efficient apparatus. The Reversine coil holder, designed for aerial and reaction tuning by duolateral coils, not only gives smooth action and fine adjustment but allows of instant reversal of the position of one coil with respect to the other. M.H. high frequency plug-in transformers, which are made for a range of wave lengths between 80 and 7,000 metres are thoroughly reliable and efficient. M.H. fixed condensers are standardised and absolutely guaranteed to the values stamped thereon, as also are the grid leaks and high resistances. A useful assembly is a case containing a range of fixed condensers, grid leaks and resistances, which is supplied in the endeavor to meet the individual requirements of experimenters. In short, McMichael apparatus exhibits the high quality and efficient design which is necessary in order to hold the confidence of the general public and assist in the wide establishment of broadcasting services.

A.C. FOR FILAMENT LIGHTING

Use may be made of alternating current at ordinary frequencies for filament lighting and satisfactory results obtained, providing there is not a large number of amplification stages which will accentuate the low frequency hum. The time lag in the heating of most valve filaments is such that there is no appreciable alteration in the thermionic emission with the alternations of the current. The filament may be connected to the house supply through a step-down transformer of suitable ratio, the secondary circuit of which is controlled either by a rheostat of the conventional type or by a variable choke. This latter method has the advantage, that a choke will work perfectly smoothly and does not give the nasty noises which are so apparent when altering the filament brightness by means of the usual coiled spring resistance. The ratio of the transformer must be such as to give rather more than the correct voltage when used on the house supply.

Such connection alone, however, is not sufficient for satisfactory operation. In a circuit where d.c. is used for filament lighting it is usual practice to base the grid on some point of the filament, e.g., low tension negative or low tension positive or perhaps so many volts less than low tension negative by the inclusion of a grid battery. In doing so, whatever the potential of the grid with regard to low tension negative, it is a fixed number of volts more negative with regard to the other end of the filament, this value being constant for a given brightness of filament. The thermionic current control exerted by the grid is therefore fixed

except for the introduction of external potentials in the grid circuit.

In the use of a.c., however, this is not so. The potential of the grid, supposing it to be based on one end of the filament, would vary with respect to the filament by an alternating potential equal to the drop in volts across the filament itself. This must, of course, lead to a variation of anode current in the opposite phase to the filament variation of potential and will cause an anode current of the frequency of the supply voltage. This anode current gives rise to the hum which so often accompanies the lighting of the filaments by means of a.c. This serious trouble may be overcome by a rather artificial method of balancing out the anode current caused by low frequency grid fluctuation. While not really tackling the trouble at its source the methods shown in Figs. 1 and 2 may be used with advantage except when the hum is

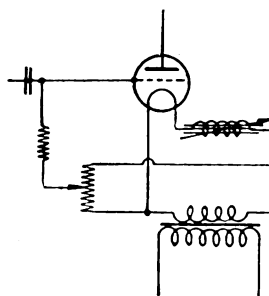


Fig. 1.

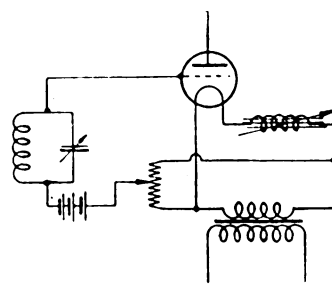


Fig. 2.

very bad. A potentiometer is placed across the filament supply and the grid base line is adjusted to a suitable point on the potentiometer until the hum is inaudible. In this position the grid is based on a point which is at a mean filament potential.

In the diagrams the potentiometer is shown placed across the actual supply voltage and not across the filament itself. With the use of a choke for filament brightness control this may cause a position of zero hum to be unattainable owing to the introduction of a lagging current and potential across the filament itself. This, of course, gives a phase difference between the filament potential and the voltage across the potentiometer and would permit of a position of minimum hum only and not one of absolute silence. In such a case the connections would require to be changed so that the potentiometer is placed across the legs of the valve stems directly, when a position of silence ought to be obtainable. A condenser of large capacity may often be used with advantage in such cases across the filament itself. Fig. 2 shows the connections possible employing the use of a grid bias battery. The use of alternating current for valve filament lighting is of a less troublesome nature with high frequency valves than with low frequency valves.—(Electrical Times.)

THE EFFICIENCY OF THE DULL-EMITTER

The most common bright emitter type of valve is one requiring a filament current of approximately .7 amps. at 4 volts, i.e., 2.8 watts. The average total emission from such valves is 7 milliamps., and the thermal efficiency, therefore, is 2.5 milliamps. per watt. If the same size of filament is used, and the 4-volt bright emitter filament is treated so as to become a dull emitter filament, it will give on an average 5 milliamps. total emission, with a filament current of .35 amps. at 1.8 volts, that is .63 watts. This represents a thermal efficiency of 8 milliamps. per watt. Most dull emitting valves, with few exceptions, have reasonable thermal efficiency. If thermal efficiency were to be considered alone, the .06 amp. filament valve stands high above all others. The thermal efficiency of this type is 35, compared with 2.5 for the R type of valve.

It will be seen that the dull emitting valve is over three times as efficient as its bright emitting brother having the same size and filament. This, however, is not the only point on which the dull emitter scores, for when compared with the performance of various makes of 4-volt .7-amp. bright emitters, the 1.8-volt .35 amp. dull emitter is found to have an average life of more than $2\frac{1}{2}$ times that of the former, if due precautions are taken that the dull emitter is operated under conditions strictly in accordance with those specified by the makers. The overwhelming superiority of the dull emitter valve both on the grounds of efficiency and life are thus clearly established and it does not require any elaborate argument to show that at present day prices, the dull emitter is the better proposition for the listener. These advantages are inherent in the valve itself apart from any arising from the use of dry cells instead of an accumulator.—(Osram Bulletin).

Telephony and Telegraphy

COMMONWEALTH P.M.G.'s DEPARTMENT Operations During June

New South Wales.—Twelve additional trunk circuits were completed and 19 country public lines erected. Three sections of trunk telephone and two sections of telegraph circuits were completed. An approximate conductor length of 286 miles of cable was jointed and a further 150 miles laid, in cable varying from 7 to 400 pair. A conductor length of 44 miles of aerial cable was erected. Six new country exchanges were opened and additional equipment provided at

seven centres. In the metropolitan area a conductor length of about 175 miles of cable ranging from 50 to 150 pair was jointed. Delivery of the automatic equipment for the City South exchange has commenced, and preliminary work is proceeding. This exchange will provide for 7,300 subscribers, with an ultimate capacity of 20,000, and will accommodate all the manual lines at present on to the City switch-board.

Victoria.—Twelve additional trunk circuits have been completed and seven country public lines erected. A conductor length of about 18 miles of cable ranging from 5 to 200 pairs was laid. Twelve new exchanges were opened and additional equipment installed at 18 centres. In the metropolitan area 3,607 conductor miles of cable ranging from 10 to 800 pair was laid.

Queensland.—Eight trunk circuits were completed and a new junction pole route comprising $5\frac{1}{2}$ miles of poles and 165 miles of wire erected. Eight new offices have been opened, additional exchange equipment installed at three centres, and additional trunk equipment installed at a further three offices. One mile 540 yd. of cable ranging from 15 to 200 pair was laid and jointed. In the metropolitan area 3 miles 720 yd. of 200 pair cable was laid and jointed. The meter battery, etc., at Central was replaced, the capacity of accumulators increased and amended junction equipment installed at Albion, and additional junction equipment installed at Toowong. The plant at South Brisbane exchange has been handed over by the contractors.

South Australia.—One country public line was erected and additional exchange equipment installed at six centres. About 83 conductor miles of cable was laid and jointed. Phonophore telephones have been installed at 10 points on the overland telegraph circuit to enable the offices to have continuous communication with adjacent stations instead of working at stated intervals only. Interference from neighboring high speed telegraph circuits is reduced by the use of this equipment.

Western Australia.—Eight trunk circuits have been completed and four country public lines erected. Two additional telegraph circuits have been completed. Twelve new exchanges were opened and additional equipment installed at five centres.

Tasmania.—One mile of aerial cable was erected and four new exchanges opened.

Electrician Annual Tables.—The 1925 edition of the Tables of Electricity Undertakings is to hand from London. The publication gives useful details regarding electricity supply and tramway undertakings in Great Britain, British Dominions and other countries. The British section is the most comprehensive, taking approximately half the space. Altogether over 2,000 undertakings are dealt with.

New Publications

Wireless Telegraphy and Telephony. By W. Greenwood, B.Sc., University Tutorial Press Ltd., London. Pp. 258. Price in Australia, 7/-.

Although many books dealing with wireless telegraphy and telephony have been published during the last few years there are scarcely any which treat the matter from the point of view of the electrical engineer who has had no special training in telegraphic work. The great majority, of course, are intended for the amateur who has little or no knowledge of the principles of electrical engineering, while at the other extreme are the detailed treatises for the specialist in radio communication. The object of the book under review is to fill the gap and treat radio communication as a branch of electrical engineering. It assumes a knowledge of the fundamentals of electrical engineering theory and practice, and attempts to give a thorough grounding in the main principles of radio telephony and telegraphy. The book opens with a chapter on oscillatory circuits, explaining the theory of the production of oscillatory currents and giving mathematical data and formulae. Chapter two goes on to discuss the nature and propagation of electromagnetic waves. Further chapters deal with the detection of electromagnetic waves, the production of high frequency oscillatory currents, the theory of thermionic valves, receiving and transmitting apparatus, high frequency measurements and principles of design. A final chapter deals in more detail with mathematical investigations of the phenomena of oscillatory circuits and wave propagation. The treatment throughout gives a clear insight into the theory of wireless telegraphy and telephony as at present understood. The book should be very useful to electrical engineers who wish to study the latest branch of their art. At the same time it gives a solid grounding to those who wish to specialise in the technical side of radio communication.

PUBLICATIONS OF THE ELECTRIC POWER CLUB

A new publication compiled by the Electric Power Club, entitled, "Power Switchboard and Switching Equipment Handbook," is now available. It is divided into four parts, (1), instructions for installation, operation and care of switchboards and equipment; (2), definitions, abbreviations and symbols; (3), adopted standards and practices; and (4), safety standards. Under these heads a great deal of valuable information for both the operating engineer and the designer is listed. A third edition of "Instructions for Care and Operation of Transformers" has also been issued. Copies of both

these publications may be obtained from the Electric Power Club, B. F. Keith building, Cleveland, Ohio, U.S.A. The price in America of the former is 50c. and of the latter 25c.

Trade Notes

Heemaf Motors.—Mr. A. J. Homewood of Melbourne is now sole distributor of Heemaf motors for Victoria and Tasmania.

The Liverpool Electric Cable Co. Ltd. have removed their Sydney warehouse to 189 Clarence Street.

A. Beal Pritchett (Aust.) Ltd., of Clarence street, Sydney, have been appointed sole agents for the Mullard Radio Valve Co. Ltd. in New South Wales, Victoria and Tasmania. The range of Mullard products includes high and low frequency receiving valves, transmitting valves, and rectifying tubes. An announcement regarding this firm will appear in the advertising pages of this journal at a later date.

An Industrial Power Installation.—Messrs. O. J. Nilsen and Co., of Melbourne and Adelaide, are carrying out an extensive power installation at the Cresco fertiliser works, Wallaroo, S.A. The work includes supply and installation of a Kelly and Lewis steam engine driving a 350 kw. G.E. generator, and between 30 and 40 B.T.H. motors. The switchboard for the power control is being built by Messrs. Nilsen and Co. The system voltage is 550 a.c.

"Lektrik" Lighting Connections.—Messrs. Noyes Bros., the agents for A. P. Lundberg and Sons, have forwarded a copy of the seventh edition of the handbook, "Lektrik Lighting Connections." This small volume contains a great deal of useful information on wiring and wiring accessories. It is illustrated with numerous diagrams and should appeal to the practical man. Copies are obtainable from Messrs. Noyes Bros. at 1/- each.

Messrs. Johnson and Phillips Ltd., electrical engineers and cable makers, London, have marked the jubilee of their foundation by the issue of an illustrated booklet descriptive of the firm's development and present activities. Commencing in 1875 with a small shop, the works have expanded till they occupy an area of 15 acres. The early work consisted of the manufacture and sale of cables, plant and stores for the telegraph industry which was then practically the only commercial application of electricity. In this connection a specialty was made of equipment for cable laying ships. Then came the development of electric lighting and the manufacture of generators through the eighties and nineties. Arc lamps and cables for lighting circuits were also extensively manufactured. The firm was one of the earliest builders of polyphase

motors and of static transformers, and the transformer department has now developed to very large dimensions. Another interesting development has taken place in the manufacture of switchgear. The growth of all these departments to their present status has been largely due to the building up of an extensive export business. Johnson and Phillips are now represented in most of the principal parts of the empire and in several foreign countries. Orders are received from all parts of the world and the firm has built up a reputation for the excellent quality of its products.

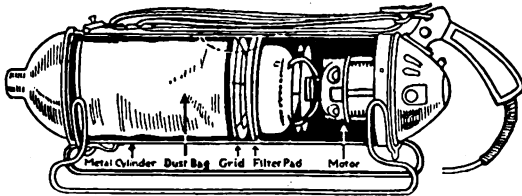
Colloid Rectifier.—The Willard colloid rectifier, which is handled by the Australian General Electric Co., is a useful piece of apparatus designed for charging low capacity accumulators such as are used for radio receivers. As sold it consists of a glass jar with anode and cathode and a packet of chemical. The chemical is dissolved in water, forming a solution which will only allow current to pass in one direction. The rectifier is made up in two sizes, one which will pass a current of $\frac{1}{4}$ to $\frac{1}{2}$ an amp. and is suitable for charging B batteries, and a larger capacity which will pass about 1 amp. and is suitable for A batteries up to about 12 amp.-hour capacity. The larger size works satisfactorily in series with a 250-watt lamp across a 230-volt a.c. circuit. This rectifier is made up by the manufacturers in a handy form in conjunction with a four-volt or six-volt accumulator, the whole outfit with three accumulator cells being retailed at £4/7/6. The larger and smaller rectifiers by themselves are sold at 25/- and 17/6 respectively.

Heater Control Switches.—The Hart Manufacturing Co. has issued an illustrated pamphlet descriptive of switches suitable for the control of electric ranges and heating devices. The series includes single and double pole three position switches in capacities from 4 amp. to 21 amp., 250 volt. There is also the Diamond H line: remote control switch, temperature control, and time control. The first is adapted for switching oven units with thermostatic control. It is actuated by an ironclad solenoid with one opening and one closing coil, with mechanical locking device. The coils are only momentarily energised during the opening and closing operations. The temperature control may be set at any temperature within its range and will maintain the oven at that temperature as long as the current is on. The time control operates the temperature control and will switch the current on and off at any predetermined time. This combination will enable the maximum efficiency to be obtained from any heating or cooking installation. Further particulars are obtainable from the manufacturer's agent, Mr. W. F. Gifford, 287 Clarence street, Sydney.

The Sack Leclanche Cell.—A primary cell which has a fairly large output and a long life should have many applications. The Sack form Leclanche cell, which is manufactured by Messrs. Siemens Bros. and Co. Ltd. combines these qualifications. In common with the usual form or Leclanche cell it has the property of largely recovering its full strength after being run down if allowed to stand awhile, but it has an advantage over the ordinary form in the quantity of electricity it will deliver before running down. In other words, it will give a larger current for a longer time than the ordinary Leclanche cell. The cell has a very low internal resistance. The negative element consists of a special mixture moulded around a central carbon and held in place by a wrapping of textile fabric. The positive element consists of an amalgamated split zinc cylinder. The electrolyte is the usual sal-ammoniac solution, and the whole is contained in an earthenware jar. This form of cell is made in several sizes. The O size is 9 in. high and 5½ in. in diameter. Its internal resistance is .10 ohm, voltage about 1.55 and rating 200 watt hours. It will give a current up to $\frac{1}{2}$ amp. without undue deterioration. It is rapidly growing in popularity for radio work, being used instead of dry cells for lighting the filaments of dull emitter valves. Another function for which its reliability renders it admirable is the provision of tripping current for circuit breakers. The price of the type O cell complete is 12/2.

Hotpoint Electric Timer.—Full automatic control of an electric oven is obtainable with the use of the Hotpoint electric timer and the Hotpoint temperature control. The latter may be set to maintain the oven at any desired temperature for an indefinite period, the former will switch the elements on and off at predetermined times. The timer is equipped with a switch which will cut it into or out of the element circuit as desired. The setting of the controls is very simple. The timer is cut into circuit by means of its small switch; the dial is turned to the time at which the setting is being done; two arms are then revolved on the dial, the "on" arm till it indicates the time at which the cooking is to commence, and the "off" arm to indicate the time at which the element must be switched off. The temperature at which the oven is to be maintained is then set, and the oven element switch turned to the high, medium or low position according to the degree of temperature required. The correct temperature and time of leaving the element on for various foods is shown in the cooking chart issued with each Hotpoint stove. The automatic control is very reliable and relieves the housewife of the necessity of always being present at the baking time. The Australian General Electric Co., which handles Hotpoint appliances, will be pleased to demonstrate and give further information regarding this control.

The Electrolux Suction Cleaner.—Electrolux Ltd., with headquarters at the corner of George and Bathurst streets, Sydney, is marketing a machine which approaches very close to the ideal as a house cleaner, for there is scarcely any portion of a room or article of furniture from which it will not remove the dust. It consists of a cylindrical container, mounted on a steel sleigh, connected by means of a flexible metallic tube to any of several cleaning fittings. The cylinder contains the operating motor and fan and the dustbag. Four fittings are provided in addition to a bent tube and a straight tube. The fittings consist of a plain suction head for cleaning carpets, stairs, curtains, etc., a brush head for cleaning hard surfaces such as walls or floors, a small suction nozzle for dealing with upholstery, mattresses, etc., and a round soft bristle brush nozzle for dusting. The whole equipment is very simple to handle. The fittings are easily attached by means of tapered air-tight

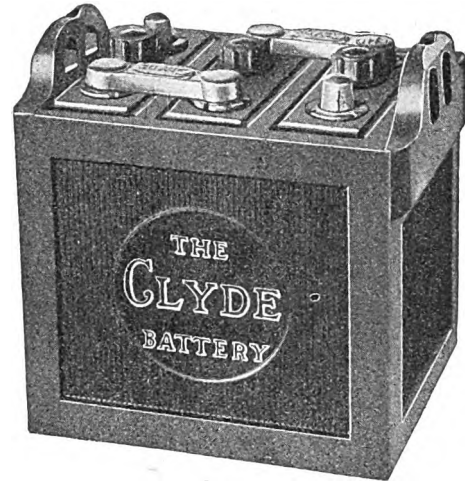


Electrolux Suction Cleaner: Sectional View

sockets and they are sufficient to cope with every class of cleaning. Floors under furniture where there is only a clearance of $1\frac{1}{4}$ in. can be thoroughly cleaned without difficulty. Any fabric from heavy rugs to clothes and curtains may be cleaned without fear of damage. The suction nozzle contains no moving brush which might injure the nap of carpets or upholstery, but the suction alone is depended upon for cleaning. This suction is extremely powerful, being equivalent to an hydraulic head of 21 in., and is largely due to the excellent fit of all parts of the apparatus. Apart from its cleaning efficiency the equipment has advantages in the protected position of the dust bag and the ease of removal of same, and in the mobility of the whole machine. The container, on its light steel runners, follows the operator around a room with only a light pull on the flexible connection. A special feature is the use of a disinfecting filter pad between the dust bag and the suction fan, which thoroughly filters and cleanses the air before returning it to the atmosphere. Extra pads are supplied and a new one should be inserted about once a fortnight. The energy consumption of the machine is about 150 watts, so that the cost of operation at $2\frac{1}{2}$ d. per unit is about 0.38d. per hour. The price is £17 and each machine is guaranteed for twelve months. The apparatus is a Swedish product of first-class

workmanship, and under ordinary conditions should have a life of at least ten years. The Electrolux is supplied for all voltages a.c. and d.c.

Clyde Batteries.—The Clyde Engineering Co. Ltd., of Granville, N.S.W., has established a fully equipped department for the manufacture of storage batteries, and turns out all classes of acid cells including radio and automobile batteries, as well as equipment for private and town lighting plants. The plates are of the usual



Clyde Automobile Battery.

pasted type spaced by treated hardwood separators. The containers for the smaller batteries are constructed of hard rubber moulded in one piece. For the convenience of customers and in order to facilitate business the company has opened a battery service station at 106 Goulburn street, Sydney. This station is primarily for the sale, distribution and service of Clyde batteries, but other makes are dealt with if required.

Mica and Micanite.—Supplies of all grades of Indian mica and of mica products, such as micanite tube and sheet, are now available from Mica Products Pty. Ltd., 94-98 Queen street, Melbourne. The firm imports its raw material direct from the mines, and manufactures all classes of mica goods.

STREET LIGHTING STANDARDS

The electric supply department of the Melbourne city council has placed a contract with the Australian General Electric Co. for the supply of 285 standards for supporting the lighting units to be installed on St. Kilda road. The standards are of two-ply corrugated steel, supported on locally made cast iron bases and are of such height that the lamp centres will be 13 ft. above the roadway. The contract price is £3,121/18/9.

Electrical Supply Undertakings of Australia

WESTERN AUSTRALIA

Town or City	Supply Authority	Type of Plant	Capacity	Distribution System	No. of Consumers
Albany	Municipal council	Suction gas and crude oil	215 kw.	440/220 volts d.c.	550
Applecross	Road board	Bulk supply	—	440/250 volts, 40 cycle, three phase a.c.	—
Armadale	Government electric supply dept.	"	—	"	—
Lassendean	"	"	30 kw.	"	—
Bayswater	Road board	"	65 kw.	"	—
Belmont	"	"	—	"	—
Beverley	Private company	Suction gas	50 kw.	220 volts d.c.	—
Boulder	Municipal council	Bulk supply	—	440/220 volts d.c.	—
Boya	Government electric supply dept.	Bulk supply	250 kw.	440/250 volts, 40 cycle, three phase a.c.	—
Bridgetown	G. H. Rundell	Suction gas and crude oil	41 kw.	440/220 volts d.c.	90
Bunbury	Municipal council	Steam	250 kw.	"	—
Busselton	"	Suction gas	75 kw.	220 volts d.c.	—
Cannington	Government electric supply dept.	Bulk supply	—	440/250 volts, 40 cycle, three phase a.c.	—
Carnarvon	Municipal council	Suction gas	29 kw.	220 volts d.c.	120
Claremont	"	Bulk supply	—	440/250 volts, 40 cycle, three phase a.c.	—
Collie	Co-operative Colliery	Steam	150 kw.	500/250 volts d.c.	—
Cottesloe	Government electric supply dept.	Bulk supply	—	440/250 volts, 40 cycle, three phase a.c.	—
Darlington	"	"	250 kw.	"	—
Fremantle	Municipal tramways and lighting board	"	4,000 kw.	"	3,765
Geraldton	Municipal council	Suction gas	165 kw.	440/220 volts d.c.	—
Gnowangerup	A. Haddon	"	24 kw.	110 volts d.c.	—
Goomalling	R. C. Mill	"	13 kw.	220 volts d.c.	—
Gooseberry Hill	Government electric supply dept.	Bulk supply	—	440/250 volts, 40 cycle, three phase a.c.	—
Gosnells	"	"	—	"	—
Greenmount	"	"	—	"	—
Guildford	Municipal council	"	—	"	400
Kalamunda	Government electric supply dept.	"	—	"	—
Kalgoorlie	Municipal council	Steam	737 kw.	440/220 volts d.c.	—
"	E. P. and L. Corporation Ltd.	"	4,850 kw.	3,000/550 volts and 220 volts, 40 cycle, three phase a.c.	—
Katanning	F. and C. Piesse	"	82 kw.	220 volts d.c.	—
Kellerberrin	C. S. Henwood	"	30 kw.	"	—
Kelmscott	Government electric supply dept.	Bulk supply	—	440/250 volts, 40 cycle, three phase a.c.	—
Kenwick	"	"	—	"	—
Kojonup	Private company	Suction gas	14 kw.	110 volts d.c.	25
Leonora	Road board	"	60 kw.	440/220 volts d.c.	—
Maddington	Government electric supply dept.	Bulk supply	—	440/250 volts, 40 cycle, three phase a.c.	—
Meckering	Private supply	Delco light	3 kw.	110 volts d.c.	—
Merredin	J. H. Page	Suction gas	36 kw.	220 volts d.c.	—
Middle Swan	Government electric supply dept.	Bulk supply	—	440/250 volts, 40 cycle, three phase a.c.	—
Midland Junction	Municipal council	"	100 kw.	"	—
Minginew	Private supply	Delco light	3 kw.	110 volts d.c.	—
Moora	Road board	Suction gas	20 kw.	220 volts d.c.	—
Mt. Magnet	Private supply	Delco light	3 kw.	110 volts d.c.	—
Narrogin	Great Southern Roller Flour Mills Ltd.	Suction gas	310 kw.	220 volts d.c.	—
Northam	Municipal council	Steam	240 kw.	440/220 volts d.c.	—
North Fremantle	"	Bulk supply	457 kw.	440/250 volts, 40 cycle, three phase a.c.	—
Perth	Government electric supply dept.	Steam	19,500 kv.a.	20,000 and 6,000 volts, 40 cycles, three phase a.c.	3,939
"	City council	Bulk supply	—	440/250 volts, 40 cycle, three phase a.c.	18,397

Electrical Supply Undertakings of Australia—(Continued).

WESTERN AUSTRALIA

Town or City	Supply Authority	Type of Plant	Capacity	Distribution System	No. of Consumers.
Queen's Park	Government electric supply dept.	Bulk supply	—	440/250 volts, 40 cycle, three phase a.c.	—
Rottnest	"	Delco light	3 kw.	110 volts d.c.	—
Southern Cross	Road board	Suction gas	35 kw.	220 volts d.c.	—
South Guildford	Government electric supply dept.	Bulk supply	—	440/250 volts, 40 cycle, three phase a.c.	—
South Perth	Road board	"	—	"	1,000
Subiaco	Municipal council	"	800 kv.a.	"	3,247
Swan View	Government electric supply dept.	"	—	"	—
Toodyay	Toodyay Electric Light and Power Co.	Suction gas	25 kw.	220 volts d.c.	—
Wagin	Municipal council	"	50 kw.	"	—
Wattle Grove	Government electric supply dept.	Bulk supply	—	440/250 volts, 40 cycle, three phase a.c.	—
Welshpool	"	"	—	"	—
Westonia	Mr. Henwood	Steam	30 kw.	220 volts d.c.	—
Wickepin	Road board	Delco light	3 kw.	110 volts d.c.	—
Wyalcatchem	J. H. Riches	Crude oil	17 kw.	220 volts d.c.	—
Yalgoo	J. Clark	Delco light	3 kw.	110 volts d.c.	—
York	Municipal council	Suction gas	80 kw.	220 volts d.c.	—

Lighting and Power

Ashburton, N.Z.—The capital expenditure of the Ashburton power board during the year ended May 11, 1925, was £78,261, while loans authorised amounted to £117,300, of which £85,400 had been raised. Up to date the board has erected 9,619 poles, 1,554 miles of wire and 204 transformers. This equipment comprises 468 miles of line, serving 1,998 consumers. During the last year, 1,325,800 units were purchased from Lake Coleridge and 8,315 units generated by the board's Diesel stand-by plant. The maximum demand was 626 kv.a. In connection with its transmission lines the board has now adopted steel poles in preference to wooden.

Auckland, N.Z.—The estimated income of the Auckland power board for the year ending Mar. 31, 1926, is £391,495. This includes £16,495 brought forward. The estimated surplus for the year is £28,495. Tenders have been accepted for two rotary converters from the English Electric Co. at £6,081 and £4,429 respectively, a rotary converter from the Metropolitan-Vickers Electrical Co. at £1,575, and a crane from Wharton Ltd. at £806.

The Waitemata power board has arrived at an agreement with the public works department whereby the department is to carry, at its own cost, a 50,000-volt line from Penrose to the Takapuna borough boundary, and to bear the expense of its maintenance. The government will also erect and maintain the two substations, one at Takapuna and the other at a point between Henderson, Hobsonville and Kumeu. The board, on its part, undertakes to erect an 11,000-volt line from the country substation to New Lynn, Helensville and Hobsonville. Tenders are being called for the supply of material for the main lines and reticulation.

Beechworth, Vic.—Zwar Bros. Pty. Ltd. has offered to give a bulk energy supply from its tannery at 4d. a unit. The council has decided to apply to the electricity commission for permission to take advantage of the offer, and to make inquiries re reticulation costs.

Blenheim, N.Z.—The Marlborough power board is considering tenders for the construction of headworks in connection with the Waihopia hydroelectric scheme. Messrs. Vickerman and Lancaster are the consulting engineers.

Bluff, N.Z.—The council has decided that all electrical consumers who pay over £200 per annum shall be classed as bulk consumers, and that the charges for bulk supply be as follows on a quarterly reading metered on the high tension side of the transformer:—£3/10/- per kv.a. for the first 100 kv.a. plus 3d. per unit; £3 per kv.a. for the second 100 kv.a. plus 3d. per unit; 15/- per kv.a. for the third 100 kv.a. plus 3d. per unit. The charges on the unit basis to be subject to a discount of five per cent for payment within 10 days. The ordinary lighting charges have been fixed as follows:—Gross 9d. nett 7½d. for first 15 units per month; gross 5½d. nett 4d. for second 15 units per month; gross 4d. nett 2½d. for all over 30 units per month. Power—4½d. nett 3d. per unit. Meter rent to be charged at 6d. per month.

Bowen, Qld.—The municipal council is calling for applications for the position of engineer in charge of the new electric supply undertaking at a salary of £425 per annum, and for four shift engineers at award rates. The plant is steam driven of 200 kw. capacity. Applications for all positions close on July 20.

Caltowie, S.A.—Consideration is being given to a scheme for electric supply from the mains of the Adelaide Electric Supply Co.

Campbelltown, N.S.W.—As from June 1 the price of electricity for lighting purposes has been reduced from 11d. to 9d. per unit.

Charlton, Vic.—The balance sheet of the Charlton Electric Light and Power Co. Ltd. for the financial year ended May 17, 1925, shows that receipts amounted to £2,017 and expenditure to £1,666. At the annual meeting the following directors were elected:—E. N. Peverill, P. Spain, W. Wylie, E. Richards, R. M. Kiunder, Mr. A. C. Bertoli is engineer and manager.

Mr. Bertoli has been appointed consulting engineer to the Korong shire council for the Wedderburn-Korongvale joint electric supply project.

Clare, S.A.—Electric supply from the new plant of the Mid-North Electricity Co. is now available. The reticulation, however, is not yet quite complete.

Clunes, Vic.—Messrs. Christie and Reynolds, consulting engineers, Melbourne, have been appointed by the shire council to furnish a report on an electrical undertaking.

Corowa, N.S.W.—At a special meeting of the municipal council it was decided to borrow £12,500 from the Bank of Australasia for the purpose of converting the system of electricity supply from direct to alternating current.

Cowra, N.S.W.—Mr. Austen Diamond, of Sydney, has been appointed electrical engineer to the municipal council in succession to Mr. L. L. Ferris, resigned.

Cue, W.A.—The Cue-Day Dawn road board is raising a loan of £1,500 for crude oil electric lighting plant.

Dannevirke, N.Z.—The electric supply has been switched on in the Southern Hawke's Bay district.

Dunedin, N.Z.—The Otago power board has just completed the second year of its activities. A total expenditure of £68,177 has been incurred to date. Negotiations with the city corporation for a bulk power supply are in train. The board is equipping a travelling showroom for the demonstration of electrical appliances.

Eudunda, S.A.—The Mid-North Electricity Co. has entered into an agreement giving it the right to supply the town with electrical energy for twenty years. A high tension line for giving the supply will probably be run from Saddleworth via Marrabel.

Euroa, Vic.—The smaller of the generating sets at the power house recently ran up to excessive speed owing to a defect in the governor. The high voltage caused damage to many lamps and fittings in the town. The machine threw the belt before it could be shut down.

Frankston, Vic.—The electricity commission has decided, in response to representations made by a deputation, to reduce the charges for bulk supply to the shire. It is estimated that the reduction will result in a benefit to the shire to the extent of about £450 per annum.

Geraldton, W.A.—The municipal council is borrowing £7,000 for extensions to the electric supply undertaking.

Gisborne, N.Z.—Energy from Waikaremoana will be available to the Poverty Bay power board within three years. The board has decided to acquire the generating plant operated by the Gisborne borough council, and the price is to be fixed by arbitration.

Glenroy, Vic.—The electric supply, which is in the hands of the state electricity commission, has been switched on. Energy is supplied through a 6,600-volt transmission line about four miles long. The voltage is stepped down in a 60 kv.a. pole type substation to 400/230 volts three phase. There are about five miles of low tension mains and it is anticipated that 80 or 90 consumers will be connected. The capital cost of the scheme is about £5,000.

Gosford, N.S.W.—The Erina shire council has authorised Mr. J. E. Donoghue, consulting engineer, Sydney, to report on a scheme for the extension of the present electricity undertaking.

Gundagai, N.S.W.—The shire council is raising a loan of £5,000 for electric supply reticulation. A bulk supply of energy should be available from Burrinjuck before next winter.

Hamilton, N.Z.—The Central power board has adopted a discount scheme whereby consumers will benefit by a five per cent reduction on any account paid within 14 days.

Hay, N.S.W.—The municipal council has granted Mr. G. M. Richards, a franchise for the purpose of providing electricity for lighting and power.

Invercargill, N.Z.—Authority has been given to the Southland power board to raise a loan of £150,000 for the completion of its electric supply works.

Kalgoorlie, W.A.—The Electric Lighting and Power Supply Corporation Ltd. shows for the year ended Dec. 31, 1924, a credit balance of £7,395.

Kangaroo Flat, Vic.—The Marong shire council has communicated with the electricity commission on the subject of provision of electric supply, but the commission has stated that as the annual expenditure would be £550, and the estimated revenue was only £510 it would be better to defer the plan for the present.

Laidley, Qld.—The shire council proposes to borrow £8,000 for an electric supply scheme.

Maclean, N.S.W.—Electric supply for the municipality is to be provided from the Nymboida hydroelectric scheme. The staff of the Clarence River county council will carry out the reticulation work. Maclean is 30 miles from Grafton and 57 miles from the Nymboida power house.

Mildura, Vic.—The new engine and generating set recently installed by the council has undergone a successful trial run.

Morpeth, N.S.W.—The municipal council has signed an agreement with the West Maitland council for the electric reticulation of the town. A period of 20 years is covered and the provision is for street lighting, power, and domestic supply.

Mudgee, N.S.W.—The municipal council has adopted a minute for the establishment of an electric lighting plant.

Mulgrave, Vic.—The shire council has been endeavoring to make arrangements for the installation of electric supply throughout the district, but its application for an order in council is being opposed by the electricity commission. The council asked the commission to make a bulk supply available but the commission intimated that this could not be done, although the latter body was willing to retail energy in a portion of the shire and make extensions as the business warranted. The Melbourne Electric Supply Co. was then approached and it agreed to make a bulk supply available. The council, however, cannot go on with the installation of reticulation mains until the order in council is granted. The Municipal Association has decided to support the shire council in a deputation to the government on the subject. The electricity commission considers that at present it is not possible to reticulate the whole of the shire on an economical basis.

Northam, W.A.—The municipal council is increasing its electric supply plant by the installation of a Belliss and Morcom engine driving a 150-kw. E.C.C. generator.

Opunake, N.Z.—The Opunake power board has decided to raise a loan of £22,000 for the reticulation of the old outer area.

Palmerston North, N.Z.—The Manawatu-Oroua power board has adopted a revised tariff, applicable to milking machine motors, which is as follows:—First 100 units per month, 4½d.; next 100 units, 3d.; all over 200 units, 1½d.

Pio Pio, N.Z.—The Wairere power board is raising its £38,500 loan by the issue of £100 debentures bearing interest at six per cent.

Queenstown, N.Z.—The hydroelectric scheme, which the engineer estimated to cost £7,000, has exceeded the estimate by almost £5,000. The ratepayers originally sanctioned a loan of £7,000, and later an additional loan of £4,000, but a still further £1,000 is required to complete the scheme.

Redcliffe, Qld.—A meeting of residents has decided that the city council should be moved to reconsider its decision to adopt the electric supply scheme submitted

by Mr. T. W. Bridger. It is felt that further consideration should be given to the proposal of the metropolitan electricity board to supply power in bulk over a transmission line from Sandgate.

Rockhampton, Qld.—The city council has obtained an order in council authorising it to borrow £10,000 at 6 per cent interest from the Queensland National Bank for extensions to the electric supply undertaking.

Seymour, Vic.—Authority has been granted to Messrs. Christie and Reynolds, consulting engineers, Melbourne, to report on extensions to the shire council's power plant.

Sutherland, N.S.W.—The shire council is calling tenders for equipment for its electric supply scheme. Energy will be supplied in bulk at 11,000 volts by the railway commissioners. Mr. H. J. Hoggan, of Sydney, is the consulting engineer.

Te Aroha, N.Z.—In answer to an enquiry from the Thames Valley power board the council has declined to consider selling its generating plant.

Thames, N.Z.—The borough council has decided that it cannot consider the proposal of the Thames Valley power board to purchase the council's electric generating plant.

Tumut, N.S.W.—Steps are being taken to develop hydroelectric power for supplying the municipality and district. Messrs. G. G. Turri and Co., of Melbourne, have submitted a scheme and the Gadara shire and Tumut municipal councils are requesting the government to issue a proclamation for the formation of a county council to control the proposed undertaking. It is stated that the company will supply capital and erect a temporary plant at Buddong Falls. Later a permanent plant will be erected and there should be sufficient power to supply the N.S.W. public works department as a supplement to the Burrinjuck scheme. The councils hope to purchase bulk supply at one halfpenny per unit.

Ulmarra, N.S.W.—The official switching on of the electric supply took place on June 9. Current is supplied from Nymboida.

Wallace, Vic.—An electric lighting plant is being installed at the butter factory. It is probable that supply will be given for the town.

Wallaroo, S.A.—Investigations are being made in an endeavor to discover the cause of serious discrepancies between the meter readings of the Wallaroo-Mt. Lyell Co., which supplies energy in bulk and the town council, which distributes the supply. Leakages on the mains seem to be occurring, giving rise to losses as high as 1,500 units per month out of 8,350 supplied. There is also some question of the accuracy of the meters. Both parties are using every endeavor to locate the trouble.

West Wyalong, N.S.W.—Mr. B. A. Beckwith, of Zeehan, Tasmania, was the successful applicant for the position of electrical engineer to the Bland shire council.

Woodside, S.A.—The Onkaparinga district council has granted to the Ambleside Milling and Lighting Co. a twenty year franchise for the supply of electricity throughout the district including Balhannah, Oakbank, Woodside, Tweedvale, Charleston, Springhead and Ambleside. A crude oil driven plant of 335 kv.a. capacity is in course of installation.

Yarrowonga, Vic.—Following on a request from the shire council the state electricity commission has agreed to take over the electric supply undertaking. The change of control will be made at an early date. The generating plant is to be overhauled and the capacity increased by replacing the 16 h.p. engine with one of 23 h.p. and installing a new 75 h.p. set.

Yeppon, Qld.—A company is being formed in Queensland, with authorised capital of £25,000 in £5 shares, under the title of the Yeppon Electricity Supply, Timber and Ice Co. Ltd., for the purpose of taking over the assets of the Yeppon Ice and Timber Co. and acting as generators and distributors of electricity for lighting and power. Mr. B. Pilkington, of Rockhampton, is consulting engineer, with Josept Kenna and Co., of the same city, as provisional secretaries.

Current Prices for Electrical Supplies

The quotations in this list represent the average retail selling prices ruling in Melbourne during the month of publication. These prices are subject to bona fide traders' discounts. Special rates are obtainable in most cases for large quantities. In general Sydney prices are slightly lower.

Adaptors—

Hardwood	doz.	11/3
Parallel	each	6/6

Blocks—

3 in. round	gross	21/3
3½ in. round	gross	23/9
6 in. x 3 in. rectangular	doz.	6/3
9 in. x 3 in. rectangular	doz.	7/6
6 in. x 6 in. square	doz.	12/6

Bushes—

½ in. ideal metal	gross	7/6
¾ in. ideal metal	gross	7/6

Bushes—

¾ in. ideal metal	gross	8/9
¾ in. plain wooden	doz.	1/6
¾ in. plain wooden	doz.	1/8
1 in. plain wooden	doz.	2/

Bells and Bell Material—

Bell transformers	each	12/6
1½ volt dry cells	each	3/-

Bells and Bell Material—

Bell wire—1/.029 d.c.c.	1,000 yd.	32/6
1/.036 d.c.c.	1,000 yd.	42/6
1/.029 d.c.c. and i.r.	1,000 yd.	50/
1/.036 d.c.c. and i.r.	1,000 yd.	60/

No. 2 porous pots	each	2/1
No. 2 jars	doz.	8/9
No. 2 zincs	each	1/3
Salammoniac	lb.	1/3
2½ in. wood box bells	each	4/6
2½ in. iron box bells	each	4/6
3 in. wood (church gong)	each	18/4
Bell presses	from each	3/9

Pocket Lamp Batteries—

Batteries, pocket lamp	each	1/10
2-cell batteries	each	2/5
3-cell batteries	each	2/8

ceiling Roses—

	English	Japan
2-plate	doz.	5/5
3-plate	doz.	13/9
		7/11

Connectors—

1-way, porcelain	doz.	2/6
2-way, porcelain	doz.	4/
3-way, porcelain	doz.	5/

Counterweights—

Porcelain	each	2/6
Brass	each	5/6
Shot for same	lb.	63d.

Casing and Cover—

Best white pine	100 ft.	12/6
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Conduit—

		Plain	Screwed
$\frac{1}{8}$ in.	100 ft.	9/2	20/
$\frac{1}{4}$ in.	100 ft.	10/	20/
$\frac{3}{8}$ in.	100 ft.	15/	7/6
1 in.	100 ft.	27/6	40/
1 $\frac{1}{4}$ in.	100 ft.	45/	60/
1 $\frac{1}{2}$ in.	100 ft.	68/	85/
2 in.	100 ft.	—	135/
$\frac{3}{4}$ in. oval	100 ft.	12/6	—

Conduit Fittings—

		$\frac{1}{2}$ in.	$\frac{3}{4}$ in.	1 in.
Grip—Tees	doz.	3/6	3/6	4/3
" Elbows	doz.	2/9	2/9	3/6
" Couplings	doz.	2/3	2/3	2/9
Crampets	gross	5/5	5/5	6/3

Conduit Fittings—

Saddles	gross	5/	5/	5/5
Screwed tees	doz.	$\frac{1}{2}$ & $\frac{3}{4}$ in.	$\frac{3}{4}$ in.	
" elbows	doz.	5/5	7/6	
" couplings	doz.	3/9	5/5	
" bell mouths	doz.	2/9	4/	
" " "	doz.	5/	5/	
" " "	1 in.	doz.	14/10	
" " "	1 $\frac{1}{4}$ in.	doz.	19/6	
" " "	1 $\frac{1}{2}$ in.	doz.	27/	

Junction Boxes—

		$\frac{1}{2}$ in. & $\frac{3}{4}$ in.	1 in.
2-way	doz.	10/10	10/10
3-way	doz.	11/3	11/3
4-way	doz.	11/3	11/3

Fuses (Cut-outs)—

		British	Japan
5 amp, anchor type	doz.	10/	5/
5 amp, round chamber	doz.	17/6	8/9
8 amp, round chamber	doz.	20/	12/6
10 amp, oblong	doz.	35/	25/
20 amp, oblong	each	—	3/

Holders—

		English	Japan
C/G., S/C. holders	doz.	11/8	8/9
$\frac{1}{2}$ in. and $\frac{3}{4}$ in. holders	doz.	11/8	8/9
Batten holders	doz.	12/6	10/

Lamps—**Metal Filament, Vacuum Type**

25 to 250 volts, 20 to 60 watt	each	2/
20 to 250 volts, 100 watt	each	5/

Gas-filled Type

20 to 250 volts, 25 to 40 watt	each	2/9
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All voltages	60 watt	each	3/3
	75 watt	each	3/9
	100 watt	each	5/3
	150 watt	each	7/
	200 watt	each	9/
	300 watt	each	13/
	500 watt	each	17/6
	750 watt	each	22/6
	1000 watt	each	27/6
	1500 watt	each	40/

Carbon Filament

All voltages, 5 to 32 candle power	doz.	24/
All voltages, 50 candle power	doz.	42/

Plugs—

5 amp two pin plugs	doz.	27/6
5 amp two pin tops	doz.	15/

Shades, Opal—

8 in.	doz.	11/3
9 in.	doz.	17/6
10 in.	doz.	21/3

Switches—

		English
5 amp s.p. pol. brass	doz.	17/6
5 " s.p. ox. copper	doz.	19/3
5 " 2-way pol. brass	doz.	30/
5 " 2-way ox. copper	doz.	33/
10 amp. s.p. pol. brass	doz.	37/6
5 " d.p. pol. brass	doz.	40/
10 " d.p. pol. brass	doz.	85/
5 " s.p. ceiling switches	each	5/6
5 " 2-way ceiling switches	each	7/6
1 " ceiling switch and rosette	each	5/6

Switches—

3 " American tumbler	doz.	24/
3 " s.p. indicating rotary	doz.	24/
3 " s.p. non-indicating rotary	doz.	22/6
3 " 2-way rotary	doz.	56/3
5 " d.p. indicating rotary	doz.	62/6
10 " d.p. indicating rotary	doz.	78/
20 " d.p. indicating rotary	doz.	150/

Switchboards—

		English	Japan
Single circuit marble 5 amp	each	11/3	9/2
Single circuit marble 10 amp	each	18/9	16/3
Two circuit marble 5 amp	each	20/	16/3
Two circuit marble 10 amp	each	25/	22/

Switchboard Frames—

6 in. x 6 in. local make	doz.	9/6
6 in. x 8 in. local make	each	1/
8 in. x 8 in. local make	each	1/3
8 in. x 10 in. local make	each	1/6
10 in. x 10 in. local make	each	1/8

Tape—

Black adhesive	lb.	2/9
Pure rubber	lb.	10/

Wire and Cables—

		Per 1,000 yd.
1/.044, 600 meg.		£5 12 6
1/.064, 600 meg.		£8 12 6
3/.036, 600 meg.		£9 15 0
7/.036, 600 meg.		£17 0 0
7/.044, 600 meg.		£21 10 0
7/.064, 600 meg.		£36 10 0

Flexibles—

		Per 100 yd.
23/36 cotton		£2 2 6
40/36 cotton		£2 12 6
70/36 cotton		£3 10 0
110/36 cotton		£4 5 0

POSITIONS VACANT

The Dubbo Lighting Co. Ltd., Dubbo, N.S.W., has a vacancy for an assistant engineer. Applications, which should be addressed to the secretary, 18 Martin place, Sydney, close on Aug. 1.

Applications are invited for the position of electrical engineer to the municipality of Queanbeyan, N.S.W. The closing date is July 23. All communications should be addressed to the town clerk, Mr. J. H. Hincksman.

Electrical Contracts

COMMONWEALTH

Dept. of Works and Railways.—Erection of electric goods elevator at G.P.O., Sydney—Standard-Waygood Ltd.

Federal Capital Commission.—Two motor generator sets for lifts—Siemens Bros. and Co. Ltd.

P.M.G.'s Dept., General.—Telephone repeater equipment—Western Electric Co. (Aust.) Ltd.; Creed telegraph apparatus—Amalgamated Wireless (A/sia) Ltd.; 46 magneto floor-pattern switchboards—200/200 line—Western Electric Co. (Aust.) Ltd.

P.M.G.'s Dept., Queensland.—19,800 glass insulators—Australian Glass Manufacturers Co. Ltd.; 50 strips of relays—British General Electric Co. Ltd.

STATES

N.S.W. Public Works Dept.—Tocumwal electric supply—poles, etc.—P. Donnelly; installation electric light, farm homes, Mittagong—W. Briggs.

South Australian Supply and Tender Board.—Battery equipment for gong construction—General Railway Signal Co. Pty. Ltd.; petrol driven welding set—Australian General Electric Co. Ltd.; telephones—Unbehaun and Johnstone Ltd.; direct current motors, protected type—Geo. Wills and Co. Ltd.

State Electricity Commission of Vic.—Galv. steel cable—Elder Smith and Co.; V.I.R. control cable—British Insulated and Helsby Cables Ltd.

Victorian Public Works Dept.—Installation of electric lighting, hospital for insane—Tolson and Co. Pty. Ltd.

Victorian Railways.—Phase shifting apparatus—Australian General Electric Co. Ltd.; ammeter, milliammeter and voltmeter—Warburton, Franki (Melb.) Ltd.; 15-ton electric travelling Goliath crane—Babcock and Wilcox Ltd.; soot blowers—A. Walker; 10 kv.a. cabin transformers—E.M.F. Electric Co. Pty. Ltd.; hinge type catenary clips—John Danks and Son Pty. Ltd.

West. Aust. Govt. Tender Board.—Transformers—Metropolitan-Vickers Elec. Co. Ltd.

GENERAL

Heidelberg Shire Council, Vic.—Transformers, Weymouth's Ltd.; high tension switchgear—Metropolitan-Vickers Electrical Co. Ltd.

Hobart City Council.—Electricity meters—Oliver and Oliver Pty. Ltd.

Melbourne City Council.—Transformers—Weymouth's Ltd.; electricity meters—Lascelles Parrington Ltd.; Measurement Ltd., Noyes Bros., W. G. Watson and Co. Ltd., Landis and Gyr.; ornamental street lighting standards—Australian General Electric Co. Ltd.; 6,000-100 c.p. metal filament lamps—J. Danks and Son Pty. Ltd.; lead covered multi-core cables—The Enfield Cable Works (Australasia) Ltd., British Insulated and Helsby Cables Ltd., Noyes Bros. (Melb.) Pty. Ltd.; single core cables—The Enfield Cable Works (Australasia) Ltd., Metropolitan Vickers Electrical Co. Ltd., Noyes Bros. (Melb.) Pty. Ltd., Johnson and Phillips Ltd.; high and low tension switchgear—Metropolitan-Vickers Electrical Co. Ltd.; replacement parts for boilers—Messrs. Babcock and Wilcox; spare parts for meters—Australian General Electric Co. Ltd.; handhole fittings for boiler-house plant—Messrs. Babcock and Wilcox.

Metropolitan Water, Sewerage and Drainage Board, Sydney.—Motors for driving concrete mixers—Metropolitan-Vickers Electrical Co. Ltd.

Sydney City Council.—Maximum demand indicators—Edison Swan Electric Co. Ltd.; bare copper cables—British Insulated and Helsby Cables Ltd.; house service fuse boxes and fuses—B. W. Electric Co. Ltd.

NEW ZEALAND

Grey Electric Power Board.—Transformers—A. S. Paterson and Co.; rubber-covered high tension underground cable—A. D. Riley and Co., Brown and Co.; oil break switches and isolation switches—A. S. Paterson and Co.; low tension apparatus for switchboards—Canterbury Engineering Co., Turnbull and Jones.

Nelson City Council.—Electric meters—P. R. Baillie and Co.

Otago Electric Power Board.—Outdoor equipment—A. D. Riley and Co.; trifurcating cable boxes—Lawrence and Hanson Electrical Co. Ltd.; armored cable—Richardson, McCable Ltd.

Public Works Dept.—Oil switches—Metropolitan-Vickers Ltd.; Coleridge, section 183, lightning arresters—Turnbull and Jones (Westinghouse)—Metropolitan-Vickers Ltd.

TENDERS OPEN

COMMONWEALTH

Federal Capital Commission.—July 20—Thirteen electric elevators.

P.M.G.'s Dept., General.—July 28—Underground and aerial cable. Aug. 11—Plugs and sleeves, switchboard cords. Sept. 15—Lamps, lamp caps, and lamp sockets, telegraph equipment. Sept. 29—Protective apparatus. Oct. 20—Jumper wire, bells, buzzers, switchboard cable. Oct. 27—Timing clocks and calculagraphs, cordless switchboards.

P.M.G.'s Dept., N.S.W.—Sept. 24—Excavating machine. Nov. 6—Automatic common battery, telephone equipment, Canberra exchange.

P.M.G.'s Dept., Victoria.—Aug. 25—Pneumatic tubes.

Works and Railways Dept.—July 27—Motors for air conditioning plant.

STATES

N.S.W. Public Works Dept.—July 27—Copper conductors, tie wire, and jointing sleeves. Aug. 4—Electrically driven pumping plant, Blackheath. Sept. 14—Electrical equipment for Cook's River bridge. Sept. 21—Telephone communication system, Barren Jack hydro-electric development.

N.S.W. Railways and Tramways.—Aug. 5—Ash conveyors for White Bay power house. Aug. 26—Two 50 kv.a. transformers. Sept. 2—Two 250 kv.a. transformers. Sept. 9—Electric travelling jib crane. Sept. 23—Four feed-water meters. Oct. 7—20,000 kw. turbo alternator. Oct. 21—Two-ton industrial electric elevator; five-ton electric overhead travelling crane. Nov. 11—Five-ton, three-motor, electric overhead travelling crane.

State Electricity Commission of Vic.—Aug. 3—Switchgear and accessory equipment. Sept. 14—3,000 kv.a. transformers and spares, armor clad switchgear. Sept. 21—250 kv.a. transformers. Nov. 9—6,600 volt and L.T. lead covered and armored cable; 22,000 volt, 3 core lead covered and pilot cable.

Victorian Railways.—July 22—Carbon brushes, porcelain strips, insulating washers. July 29—Point detection transformers. Aug. 5—Metal filament lamps, 46 watt, 116 volts. Aug. 19—Waterproof copper clad line wire. Aug. 26—Tramway rails and fishplates; lead covered dry core telephone cable. Sept. 16—Three phase a.c. induction motor. Oct. 7—Electric cables, two electric transporters.

Victorian State Coal Mine.—July 20—Ammeters.

GENERAL

Clarence River County Council, N.S.W.—July 31—33,000 volt transformer, 11,000/400 volt distribution transformer.

Corowa Municipal Council, N.S.W.—Aug. 5—Meters, motors, and fans.

Melbourne and Metropolitan Tramways Board.—Aug. 4—Tramway permanent way. Aug. 25—Storage battery plates.

Newcastle City Council, N.S.W.—Oct. 15—2,000 kw. or 1,500 kw. turbo alternator and condensing plant.

Sutherland Shire Council, N.S.W.—Sept. 1—Insulators, bare copper cables, transformers, meters, switchgear, lightning arresters, street light fittings.

Sydney City Council.—July 27—5,000 kv.a. transformer, gas filled lamps, H.T. and L.T. cables. Sept. 7—33,000 volt lead covered cable. Oct. 6—Fibre conduits.

NEW ZEALAND

Franklin Electric Power Board.—Aug. 3—Squirrel cage motors.

Invercargill Borough Council.—Aug. 17—Single phase transformers, underground cable.

Marlborough Electric Power Board.—Sept. 22—Two 750 h.p. turbines with generators, switchboard, etc.

Public Works Dept.—Sept. 29—Waikato power scheme, transmission line steel towers, 110,000 volt switchgear and steel work; 50,000 volt switchgear and steel work; 110,000 volt transformers. Oct. 13—Waikato power scheme, 110,000 volt suspension insulators, suspension insulator clamps.

Thames Valley Electric Power Board.—July 27—Fifteen 11,000 volt transformers.

STANDARD VOLTAGES ESTABLISHED

The Australian Commonwealth Engineering Standards Association has laid down standards for the voltage and frequency of electric supply throughout Australia, as follow:—

- (1) 230 volts shall be adopted as the standard pressure at consumer's terminals.
- (2) The standard voltages for new high and extra high pressure systems and installations shall be as follow:—2,200, 6,600, 11,000, 22,000, 33,000, 44,000, 66,000, 88,000, 110,000, 132,000, but 2,200 volts shall only be used in systems other than public supply systems and where special circumstances warrant the adoption of a voltage lower than 6,600.
- (3) The standard frequency for alternating current supply shall be 50 cycles, provided that a frequency of 25 cycles may be used for special industries for which the advantages of the lower frequency are such as obviously to outweigh other considerations.

THE GENESIS OF THE G.E.C.

During the recent tour through Great Britain of the Young Australia League, the party was entertained by the General Electric Co. at the Witton works. Sir Hugo Hirst, chairman of the G.E.C., presided at the luncheon, and in the course of an address gave some interesting facts regarding the foundation of this large enterprise. He said:—

In the starting of my own career, Australia played a very important part, and if certain things had happened, or had not happened, 40 years ago, you would not be here to-day, and there would be no General Electric Co. I am one of the founders of the company; it would not have been founded but for me. As a young man I started my career with the Electrical Power Storage Co. In the early days of electrical engineering the vision of what electricity might do existed, but as frequently happens with pioneers the speed at which its results might be obtained was over-rated, and it so happened that that company fell on evil days; it discharged the largest number of its staff, and I was one. That same day I noticed that a Manchester company advertised for a young man to go to Australia and open up a branch for their medical batteries, electric gas-lighters, electric bells, etc. I obtained the job, but was sent home to my father to obtain the necessary guarantee that I was of age, and on my return to London I met a friend whom I told, with great excitement, of my wonderful chance. To my surprise he called me a fool. "If you like to go to Australia mining or farming," he said, "good luck to you; but don't believe in the future of electricity. If it has a future there will be more business five miles from Charing Cross than in the whole of Australia."

The next morning I saw in the papers that a bank had failed in Australia; the following morning some more important failures had occurred—it was the crash of 1884—and the two things together prevailed upon me to press my directors to relieve me of the contract. They were reluctant, as £10,000 worth of material had been manufactured and was ready for shipment. I then offered to work for practically no salary, just on commission, if they would allow me to sell that stock in London. A shop was taken in Queen Victoria street, to get rid of the Australian stock, under the name of "The General Electric Apparatus Co." The enterprise had vitality; we dropped the "Apparatus" and it became, as it was, the small beginning of The General Electric Company Ltd., which is to-day one of the greatest industrial concerns, and a great asset to this country.

The new electric tramway service running from the corner of Collins and William streets, Melbourne, branching through Royal Park to West Brunswick, and connecting up with the existing Essendon and Flemington line, has been put into operation.

NEWCASTLE CITY COUNCIL

ELECTRIC SUPPLY DEPARTMENT

Tenders are invited for the supply and delivery of one 2,000 kw. or alternatively, one 1,500 kw. Turbo Alternator complete with condensing plant, and are returnable not later than 4 p.m. on October 15, 1925. The lowest or any tender not necessarily accepted.

Specifications at a charge of 7/6 each and all particulars may be obtained from the Electric Supply Department, Watt street, Newcastle, N.S.W.

JOHN GLASSOP, Town Clerk.





Editorial





SAFETY REGULATIONS FOR FACTORIES

Experience is notably a hard teacher, and this applies with particular force when the lesson is driven home through loss of life. It is regrettable that during recent years several fatal accidents have been brought about through faulty insulation of electrical equipment in factories. Good workmanship and adequate maintenance of the installations would have prevented most of these accidents, but unfortunately carelessness has been allowed to hold sway, and official attention is seldom drawn to undesirable or unsafe conditions until a disaster occurs. However, when trouble does come it is well that the lesson be truly taken to heart. The fruit of this bitter experience is revealed in the recent issue of regulations governing the use of electricity in factories within the state of Victoria. The substance of these regulations is published on another page, and they will be recognised as supplying a long felt want. The pity is that their application is necessarily restricted to working places, and that private individuals cannot be adequately protected against the consequences of ignorance and carelessness.

STANDARDISATION IN ELECTRICAL SUPPLY

The provision of adequate service to the community in supplying articles of any kind demands that the price be kept to the lowest possible figure. Modern manufacturing methods have achieved wonderful results in many instances in the direction of price reduction, but there are many lines in which production methods are handicapped by the variety in types of product. The narrowing down of types to the fewest possible is now recognised as essential to efficiency, and attention is being turned towards finding out what are the types and sizes of apparatus and goods in most general demand, and which are the most conveniently manufactured. Following on this standards are being set up, conformity with which will assist the manufacturer to reduce his costs, and eliminate the confusion resulting from the use of a multiplicity of types. One of the foremost of many bodies working along these lines is the British Engineering Standards Association, whose work and publications are of the utmost value.

The scope for standardisation work is tremendous, for the field covers practically every

manufactured article. Electricity, for instance, which is not usually considered as an article, can be handled with considerably reduced cost and increased efficiency if standardised as to voltage and frequency of supply. Such standardisation not only permits of the interconnection of systems, resulting in enhanced reliability and reduced stand-by charges, but allows the manufacturer of electrical equipment to reduce his costs through the reduction in the number of types of apparatus. Such standardisation of electric supply has recently been approved by the electricity commissioners in Great Britain; while the Commonwealth Engineering Standards Association, the body responsible for the establishment of standards applicable to Australian conditions, has come to a decision regarding voltages and frequencies for general use throughout Australia.

The British electricity commissioners have standardised on three phase 50 cycle a.c. supply at high pressures of 6,600, 11,000, 33,000, 49,500 or 66,000 volts. The mains are to consist of underground cables, lead sheathed and either armored and laid direct in the ground, drawn into ducts or laid in compound filled troughing. The British Engineering Standards Association has been dealing with the question of a standard low voltage for supply, but has found some little difficulty in arriving at a decision that would be acceptable to all parties, in view of the numerous systems at present in use. A voltage of 230 for ordinary supply has finally been decided upon.

The Commonwealth Engineering Standards Association has dealt with the matter very fully and its decision is very opportune in view of the steady expansion of electric supply and the commencement that is already being made with interconnection of systems. The standard frequency adopted for a.c. supply is 50 cycles, but 25 cycles may be used under special circumstances. For high tension supply voltages of 6,600, 11,000, 22,000, 33,000, 44,000, 66,000, 88,000, 110,000, and 132,000 are the standards, and under certain conditions 2,200 volts also may be used. As with the British Association the adoption of a standard for low voltage supply proved to be the most difficult proposition. For convenience the committee dealing with the matter was divided into two sections, one representing New South Wales and Queensland, the other the remaining states. The choice lay between 240 and 230 volts. A difference of opinion arose between the two sections, not because one voltage was superior to the other,

but from the very natural reason that 240 volts had the widest use in New South Wales and Queensland while 230 was most generally used in Victoria and South Australia. There being nothing to choose between the systems, it was finally decided to leave the decision to the result or what might almost be termed a toss up. The British association was deliberating on a similar problem and it was agreed that whatever voltage was adopted for Great Britain would be used in Australia. The decision fell for 230 volts, and this, therefore, has become the Commonwealth standard. It is satisfactory to know that a decision has been arrived at on a matter of such vital importance to the electrical industry, and also to realise that the decision has been made through means which can carry no suspicion of bias of any kind. What a pity that our railways were not originally planned by men as fair minded as the members of the electrical sectional committee of the Commonwealth Engineering Standards Association!

REFRIGERATION AS A FIELD

A Victorian shire council recently applied to the minister for public works for permission to install a refrigerating plant as an adjunct to the electricity undertaking. The minister pointed out that the local government act precluded such a proposal, and he would not hold out any hope of amending legislation being introduced by the government, on the ground that "the introduction of a provision to undertake trading concerns would be a bad principle."

The desire of the council to have a refrigerating plant linked to its mains is a natural one. Refrigeration furnishes a good load for any electric supply undertaking, and in a climate such as we enjoy every town should have an ice plant, cool stores and the like. At the same time there should be no need for a municipal body to embark on such an enterprise. It could very well be left to private interests. By encouraging the establishment of a refrigeration and cool storage plant this particular council would add a new consumer to its mains, and after all what it wants to do is to sell more energy from its power station. It is gratifying to find those controlling electric supply plants looking for new outlets for energy generated.

ATTENTION TO CUSTOMERS

A great deal is being said and written about the art and science of salesmanship. Competition in business is so keen, it is said, that the salesman must be trained up to the highest pitch of efficiency, must know his goods, must be somewhat of a practical psychologist and must have an attractive personality if he is to bring busi-

ness to his firm. The most important part of the electrical merchandising organisation is its point of contact with the public, therefore the retail salesman, above all others, should be efficient, courteous and attentive. This is the theory, and it is quite right. But what of the practice.

Let a prospective buyer walk into the average electrical shop and await service. If the shop is practically empty of customers he may get attention immediately and with fair smartness. In many cases, however, the salesmen appear to be doing anything but attending to the customers. One converses with a traveller from a wholesale house, another is engaged in wiring up a two-pin plug, perhaps another is writing out orders—all very necessary operations, but really subordinate to the main purpose of the establishment. The customer often waits several minutes, and is made to feel that he does not matter.

Of course there are exceptions to this. Some of the electrical houses give prompt and courteous attention and their salesmen are to be commended for their willingness to help and their patience with a sometimes very trying public. At the same time many electrical retailers would do well to give careful consideration to the attitude of their employees, and to reflect that the flattery or a little attention will often convert a casual buyer into a regular customer.

Notes and Personals

The city council of Bendigo, Vic., has taken steps towards framing a by-law to render it compulsory to lay electric cables underground in the city.

The Brisbane tramway trust has placed a further order with the Meadowbank Manufacturing Co., Sydney, for 15 car bodies, of the drop-centre type. The trust will assemble the cars in its own workshop.

The commission appointed by the Fuller administration to investigate the question of electricity supply in the city of Sydney, N.S.W., and its environs, has lapsed without making any enquiry.

Mr. L. G. Pardoe, a graduate of Queensland university in electrical engineering, has returned after three years in the works of the British Thomson Houston Co., England. Mr. Pardoe has received an appointment with the Brisbane tramway trust.

Mr. H. M. Miller, assistant electrical engineer of the public works department, New Zealand, has left for a tour during which he will visit Java, Japan, China, Canada, and the United States. He will investigate matters connected with the generation and distribution of electricity, including methods of administration and of charging for supply.

The Christchurch tramway board, New Zealand, has received authority to borrow £20,000 for general development works.

Mr. J. Scharfl, of the Electricity Meter Manufacturing Co. Ltd., Sydney, who has been on a business tour abroad, returned to Australia early in August.

Mr. H. F. Buttenshaw, A.M.I.E.E., of Crompton and Co. Ltd., recently arrived in Australia from Yorkshire, England. He is now located at Messrs. Crompton's Sydney office.

The Electrical Employers' Association of N.S.W., in order to stimulate interest in wireless development, has opened a radio broadcast bureau at 2 Castlereagh street, Sydney, where information on matters relating to wireless broadcasting and reception can be obtained. Mr. C. C. Faulkner, of the Daily Telegraph literary staff has been appointed director.

The Electric Light and Power Supply Corporation Limited, which supplies current to the municipalities of Petersham, Balmain, Newtown, Leichhardt, and Ashfield, N.S.W., as from Aug. 1, reduced the charges for electricity as follows: Lighting: uniform rate of 4½d. per unit, or maximum demand 5½d. for first hour, and 2½d. for all in excess; power, 1½d. per unit.

The trades and labor council of Queensland is asking that air brakes be fitted on the Brisbane trams. Experience in other centres has shown that such equipment is very desirable, as hand braking is not always satisfactory from the point of view of safety, and the magnetic brake imposes a considerable strain on the running equipment when used for service stops.

The city council of Wellington, N.Z., is adopting a concession ticket system on its tramways whereby regular travellers will be able to travel over three, four and five sections for a three-penny fare. This is being done with a view to encouraging people to live in the outer suburban areas and in order to meet bus competition. The present fares for three, four and five sections are 4d., 5d., and 6d. respectively.

Mr. A. E. Axon, B.E., of Brisbane, is returning to Australia, after spending some two and a half years in Great Britain and America. The greater part of this time was spent with the Metropolitan-Vickers Electrical Co. He inspected many electric supply systems on the continent and in America, and spent some little time with the Pacific Gas and Electric Co., U.S.A., acquiring first-hand knowledge of extra high tension transmission practice.

The paper industry which the Amalgamated Zinc (De Bavay's) Co. proposes to establish in Tasmania will mean a good industrial load for the hydroelectric department. In Canada the manufacture of paper takes practically 100 h.p. for each ton of daily output. The company has

made application to the tariff board for a duty of 40 per cent and the scheme is contingent on this protection being granted.

The electric supply committee of the Sydney city council recently put forward a proposal that a money grant be made to the Electrical Development Association of N.S.W., but the city solicitor notified the council that it had not the power to do this. Legislation, therefore, is to be introduced altering the council's constitution to permit of a grant, such as £4,000 per annum for three years, being made.

A recent report of the supply engineer of the Auckland power board, N.Z., states that the show room established by the board is greatly appreciated by the public. The majority of the inquiries so far have been for hot water service. Fully 90 per cent of the early installations for electric cooking and water heating in the city are traceable to the showroom demonstrations. Since the end of January last 158 stoves and 284 water heaters have been connected. The average price was between £25 and £30. It has been particularly noticeable that after each advertisement in the daily papers the number of inquiries has increased considerably. The average weekly cost for lighting, ironing, cooking, and presumably, some radiator heating of 16 consumers taken at random came to 6/0½. This was taken over a winter period of six weeks when consumption is high.

THE NEW WAR CONVERSION LOAN

The first internal war loan was launched in Australia on July 24, 1915, the second on December 1, 1915, the third on June 1, 1916, and the fourth on December 23, 1916.

Every one will remember what this money was required for. It was to maintain in action those gallant Anzacs, many of whom, alas, left their brave bodies on the shell-swept slopes of Gallipoli or beneath the poppies of Flanders fields. There was no fear about getting the necessary money in those days. In the first war loan, nearly three times the amount asked for was subscribed.

In those days, people realised their national duty to the full, and it is felt by the Commonwealth loan authorities that the position needs only to be put carefully and plainly before the people to-day, and they will respond just as freely. The call of national duty beats just as strongly in the Australian's breast to-day as ever. The total amount raised by these first four war loans was £80,216,790; but since the war the Commonwealth government has redeemed a good many millions of this debt out of surplus revenue, and a considerable portion was converted into the longer-dated loans which were

subsequently floated, thus leaving an amount of about £67,000,000, which has to be raised before December 15, when the four loans fall due for payment.

It will be necessary, of course, to know just where we stand some time before that date arrives, and for this reason the loan campaign is being launched immediately.

There are two ways of meeting our indebtedness on its due date; firstly, those who hold bonds in one or other of these first four loans are invited to convert them into the new conversion loan now being raised. At present they are getting $4\frac{1}{2}$ per cent, free of both federal and state income tax. In the new loan they are offered $5\frac{1}{2}$ per cent, free of state income tax, which represents a very reasonable offer on the part of the authorities for such a gilt-edged security. Secondly, those who do not hold bonds in the first four loans are invited to make cash applications at the same rate, viz., $5\frac{1}{2}$ per cent, free of state income tax. The method of application is very simple.

Citizens may fill in an application at any bank, or savings bank, or money order post office in Australia, or may lodge their applications with any member of a recognised stock exchange.

REGULATIONS GOVERNING THE USE OF ELECTRICITY IN FACTORIES

Regulations governing the use of electrical apparatus in factories have recently been drawn up, and approved by the Victorian state executive council, and are to be added to the general factory regulations. The aim of these new rules is to ensure that all current carrying conductors shall be so insulated and protected that accidental contact therewith shall be impossible.

Contact wires of electric cranes and hoists must be properly guarded, and wherever it is necessary to use uninsulated wires a notice must be fixed near them directing attention to the danger. Switchboards having exposed conductors or switchgear must be properly enclosed. All flexible conductors and electrical appliances must be maintained in good order and kept properly insulated. Efficient connections must be maintained with all hand lamps, flat irons and similar small apparatus. Hand lamps must each be equipped with an insulating handle and enclosed in a wire cage insulated from the lamp socket. Flexible connections to portable tools, such as welders, drills, etc., must be either of the three conductor type enclosed in tough rubber tubing or hard wear resisting braiding, or of the two conductor type, well insulated and enclosed in a continuous braiding of woven wire. The conductors must be connected to the plugs or terminal boxes in such a manner that there will be no stress on the conductor or insulation.

Three pin plugs must be used for connection to the supply, and the plugs and sockets must be so arranged that wrong insertion will be impossible. Efficient connection of the body or frame of the portable device with the earth must be effected, by means of the third conductor of the three conductor flexible or by means of the wire braiding of the two conductor flexible. The earthing conductor must be attached to the third pin of the three pin plug, which must make good connection to earth.

POPULARISING ELECTRICITY

The Sydney city council has under consideration various proposals for popularising the use of electricity in homes. At a meeting of the electricity supply committee, held on July 13, a sub-committee of five was appointed to investigate details of a publicity campaign suggested by Mr. H. R. Forbes Mackay, general manager. One scheme is that the electricity department shall let out to approved users electric cookers on the hire purchase system. Experts had reported on a number of makes of electric cookers and of these three or four were recommended as being reliable.

In reply to Alderman W. P. McElhone's contention that the present electric cookers were too costly for ordinary use, Mr. Mackay stated there was no doubt as to the efficiency of electric cookers but the only question was one of cost. It was for demonstration purposes that he wanted the trial made, to bear out his contention that with care in use, electricity was as cheap as gas or any other cooking agent.

INSTITUTION OF ENGINEERS

Tasmania Division

At the general meeting of the Tasmania division of the Institution of Engineers, Australia, on July 28, Mr. Bertram Wood read a paper on Electro-Chemical Industries. He pointed out that Tasmania was very favorably situated with regard to water power, having some 600,000 h.p. available for development as the need arises. At the present rate of development it will be many years before the domestic and ordinary factory loads consume one-tenth of the amount of power available, and it is thus desirable that electro-chemical industries, which consume large blocks of power, should be attracted to the state. Mr. Wood described the more important processes connected with the manufacture of the following products by electro-chemical and electro-metallurgical processes: Aluminium, calcium carbide, caustic soda, chlorine, fixation of atmospheric nitrogen, ferro alloys, hydrogen, oxygen, zinc and copper, and touched on electric furnace practice.

Variable Speed A.C. Commutator Motors

By Reginald A. Gladwell*

Due to the ease of generating and transmitting, and to the simplicity and robustness of the ordinary induction motor, a.c. distribution is coming into more and more extensive use. With the almost universal adoption of this system, a demand has arisen for an a.c. motor that will operate economically over a wide range of speeds. In the past, speed variation has only been obtained in one of the following ways:

- (a) By converting the a.c. to d.c., and using d.c. motors.
- (b) By multipolar connected induction motors.
- (c) By the cascade connected system.
- (d) By wound rotor induction motors.

The first method involves a comparatively high initial cost. The second gives only a very limited

supply is brought in through the primary winding of a transformer to the ends of the stator winding, which is connected in delta. The secondary winding of the transformer is connected through the brushes to the armature of the motor, thus the machine is essentially a series one, having the stator and rotor connected in series through a transformer winding. The reason for introducing a transformer between stator and rotor is to overcome commutating troubles that would result if the high supply voltage had to be passed through the rotor winding. In actual practice a transformer is used on all voltages over 200. It is, however, of small dimensions, since it deals with the slip power which is only a fraction of the total input

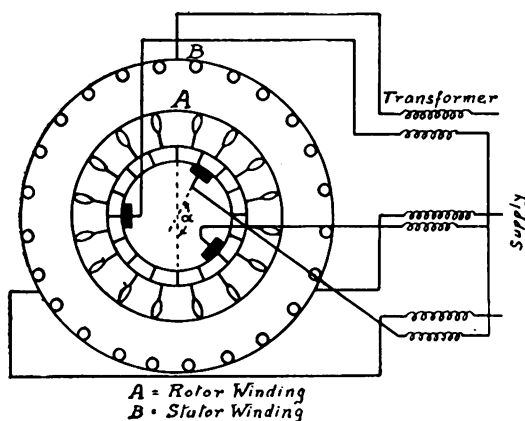


Fig. 1.

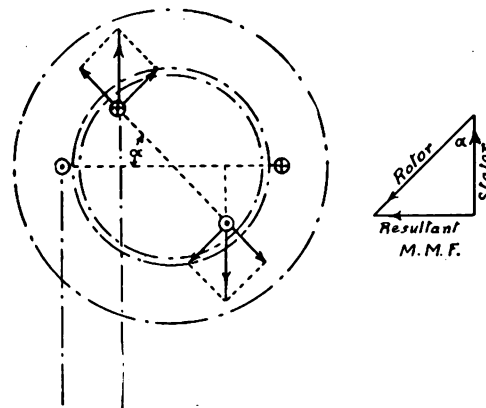


Fig. 2.

and fixed number of speeds, as also does the third, while the fourth is a very inefficient way of working, as the motor has the speed characteristics of a series wound, d.c. machine, and the disadvantage of a very limited range of speed.

The Georges Motor

To overcome these disadvantages, an a.c. commutating motor having a commutator similar to a d.c. machine was introduced by Georges in 1891. Considerable difficulty was experienced with this design due to commutation trouble, but this was overcome in later years, and many of the machines are now operating successfully. The stator of this motor is similar in construction to the stator of the present-day induction motor, and the rotating armature is much the same as a d.c. armature with the exception that the commutator is of larger dimensions than that of a d.c. machine having the same rating.

The method of connecting is as shown in Fig. 1, from which it will be seen that the

of the motor. As this machine, due to its series characteristics, tends to speed up when the load is taken off, the transformer is so designed that the iron in the core becomes saturated when it supplies a large voltage. Thus, the flux of the motor is increased, since the magnetising current of the transformer circulates in the stator winding, and the light running speed of the motor is prevented from reaching a dangerously high value. The maximum speed can also be limited by reducing the number of turns on the transformer winding, for which purpose several tapings are usually provided.

By means of suitable gearing the brush rocker of the motor can be rotated, and thus the axis of the rotor m.m.f. with reference to the stator m.m.f. can be rotated through 180 deg., the resultant of these two m.m.f.'s (Fig. 2) producing the flux of the machine. The e.m.f. induced in the stator is fixed by the current flowing in the windings and, as mentioned above, the angle between the two m.m.f.'s. Adding to this the impedance drop, another e.m.f. is required, except

*Aust. General Electric Co., Melbourne.

at synchronous speed, to give a total resultant equal to the applied line voltage. This is supplied by the rotor, which will rotate at the speed necessary to produce it. At synchronism this e.m.f. will be zero, and at other speeds its magnitude will determine the amount of speed above or below synchronism, while its direction will determine whether the speed is above or below the synchronous speed. Thus, by altering the brush position, an infinite number of speeds, usually within a range of 3/1, can be obtained. The disadvantage of the Georges series motor is the series characteristics, which limit the use of the motor to conditions where the torque is constant at all speeds, such as pump and fan drives.

Three Phase Shunt Characteristic Motor

To meet the demand for a motor having shunt characteristics, the Eichberg three phase commutator motor was designed. Mechanically this motor is similar in construction to the Georges

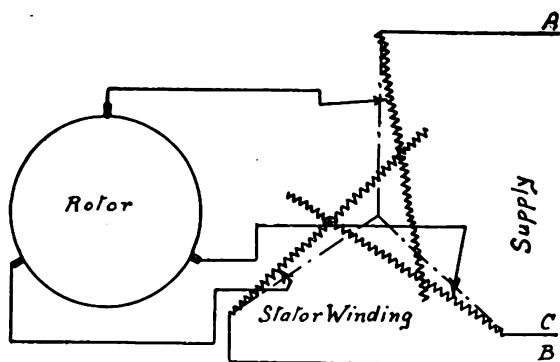


Fig. 3.

motor described above. The method of connecting is as shown in Fig. 3, from which it will be seen that the stator winding is connected direct to the supply, and is fitted with a number of tappings, to which, through a suitable controller, the rotor circuit is connected. It will also be noted that the star point of the stator is closed through a polygon. Thus any voltage out of phase from the true star voltage of the supply is impressed on the rotor circuit, making possible power factor corrections.

In this design of machine, the flux, due to the rotating field of the stator windings, cuts the rotor windings and induces in them an e.m.f., the value of which is dependent on the frequency, the magnitude of the flux, and the number of turns in the rotor winding. At standstill this flux cuts the windings at maximum speed, and when the rotor is moved in the same direction as the flux, the frequency of cutting decreases, inducing in the winding proportionately lower voltage at a proportionately lower frequency. It should be noted, however, that as the brushes remain stationary, the frequency on them will

remain the same as the supply frequency, and will not vary with that in the rotor windings. Therefore, the voltage appearing at the brushes will be maximum at standstill, zero at synchronism, and at twice synchronous speed a value equal to the standstill value, but opposite in sign.

Using the stator winding as a regulating transformer as shown in Fig. 3, the brushes are connected direct to the supply, thus a definite voltage is impressed on them, and the current in the armature will be produced by the resultant voltage existing in the windings. On light load the induced e.m.f. in the rotor winding will be practically equal to the e.m.f. impressed on the brushes, but as the load increases, current will appear in the rotor windings, the flux of which, together with the stator flux, will produce the torque. When the load is increased, the rotor will slow down slightly, so that the induced e.m.f. can exceed the impressed by the amount

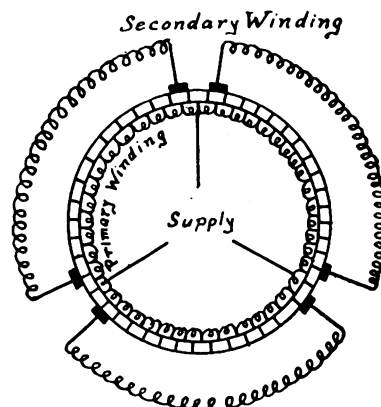


Fig. 4.

required to force the necessary current through the impedance of the rotor circuit. This change in speed is, however, extremely small, as the impedance of the circuit is very low.

From the foregoing it will be seen that speed variation can be obtained by varying the impressed voltage on the brushes, and if the stator winding is connected beyond the star point, speeds above synchronism can be obtained, as the impressed voltage will be in the opposite direction. This type of machine has speed characteristics of a shunt wound d.c. motor, but the number of speeds obtainable is very limited, as they depend on the number of points on the stator winding, which of necessity must be limited.

Schrage Three Phase Variable Speed Motor

From the description of the Eichberg motor, and in fact with nearly all a.c. motors, it will be noted that in order to maintain a speed lower than synchronous speed, there must be impressed on the rotor circuits an e.m.f. of the same frequency, and opposite in sense to the e.m.f.

induced in them by the rotating stator flux, and when speeds above synchronism are desired, this impressed e.m.f. must be reversed.

The Schrage variable speed motor was introduced to overcome the physical difficulties experienced with the Eichberg type of machine when dealing with the impressed e.m.f. feature. In order to describe this design, it is necessary to refer to Fig. 4, which represents a primary winding connected to segments of a stationary commutator. If an e.m.f. is impressed on this winding, the voltage between any two brushes will be proportional to the angular displacement between them, and if the brushes with a fixed

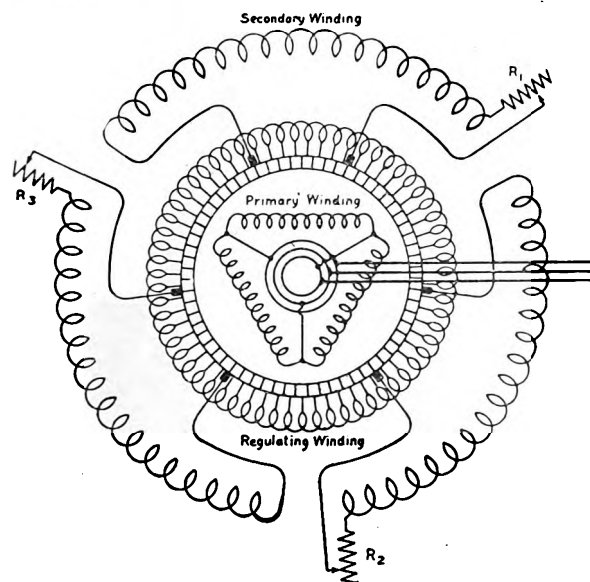


Fig. 5.

displacement are rotated round the commutator, the e.m.f. between them will remain constant, but the frequency of this e.m.f. will vary with the speed. The e.m.f. and frequency in the secondary windings connected to the brushes will be the same as that existing at the brushes, and the value of this voltage can be changed by varying the displacement, also the phase relation can be changed by altering the axis.

When the brushes connected to any one phase are brought together, thus short circuiting the winding, conditions exactly the same as that in an ordinary induction motor with its secondary winding short circuited exist, and a motor connected in this manner would have similar characteristics. If the brushes are separated the e.m.f. appears in the secondary windings, thus causing a drop in speed, to enable the induced e.m.f. due to the stator winding flux to equal this injected e.m.f. Therefore by altering the displacement of the brushes an infinite number of speeds can be obtained. In actual practice it would be extremely difficult to control the position of the brushes as they revolve, and

to overcome this the primary winding is made to rotate whilst the secondary is stationary, the connections being as shown in Fig. 5.

So that the machine will be suitable for operating on the usual commercial voltages, which are too high to pass through a commutator, a transformer action is introduced in its primary circuit by using two windings. One winding having a large number of turns is connected to the supply sliprings, and the other, which is called the regulating winding (Fig. 5), having a smaller number, is connected to the com-

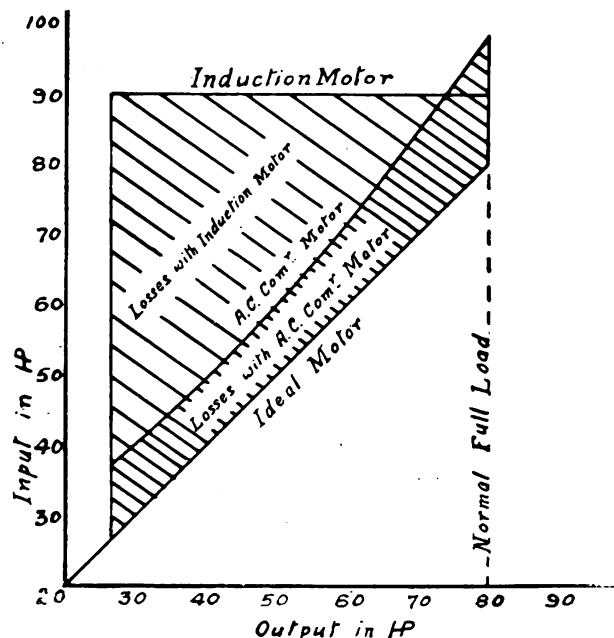


Fig. 6.

Comparison of losses in obtaining speed variation by a.c. commutator motor and induction motor with rotor resistances.

mutator. Thus the voltage between segments is reduced to a very low value. Owing to this low voltage between segments, high starting torque can be obtained without danger of injuring the commutator. The brush gear is arranged on two separate yokes, which are geared together. The "starts" of each secondary winding are connected to brushes on one yoke, and the "finishes" to the brushes on the other. Speed variation is obtained by turning the pinion of the brush gear which causes the brushes to travel in opposite directions giving, within a predetermined range, any desired voltage across the terminals of the secondary winding. By displacing the axis of the brushes, which is equivalent to tilting the phase of the regulating winding, power factor improvement can be obtained. This provides for larger speed ranges and better operating characteristics at low speeds. This movement of the brushes also increases the starting torque and the maximum torque of the machine, for it brings the secondary current and the flux into better relationship with one another. With the brushes set in the

minimum speed position twice full load starting torque can be obtained, the speed torque curves being similar in form to those of an ordinary induction motor.

An interesting feature of this design is that the motor can be started up against twice full load torque without the use of secondary resistance. This is possibly due to the fact that at sub-synchronous speeds the regulating winding or commutator e.m.f. opposes the secondary winding e.m.f. which is a maximum at standstill. Therefore, when starting, it is the difference of these two e.m.f.'s which produces the secondary current. Also it is the difference of the m.m.f.'s of the regulating and secondary windings that is reflected into the primary windings so that even if the secondary current is equal to twice full load the current in the primary winding might not exceed one and a quarter times full load value. In some applications creeping speeds are

necessary for short periods. These exceptionally low speeds can be obtained by inserting small resistances, as shown in Fig. 5, in each of the secondary phases.

In the opening paragraph of this article, mention was made of obtaining speed variation by inserting resistance in the secondary or rotor circuit of an induction motor. Fig. 6 illustrates the efficiency of this method compared with that of the Schrage design machine. The exceptionally high efficiency of the commutating motor is due to the fact that the power input is proportional to the output of the machine, while with the induction motor the power input is the same at all speeds. One of the outstanding advantages of the Schrage design is the simplicity of the starting equipment which, owing to the small starting current, consists only of an oil circuit breaker interlocked with the bottom speed position of the brush gear.

Combating Corrosion of Condenser Tubes

In a paper read early this year before the Liverpool Engineering Society, Mr. J. Austin gave some interesting data on recent endeavors to prevent corrosion of the tubes of marine condensers. As a great many land power stations use sea water for circulating purposes and are faced with corrosion problems similar to those which arise in marine practice, the paper is of great interest to power station operators. A badly corroded tube allows leakage to take place from the salt circulating water to the condensate, thus impairing the purity of the boiler feed and giving rise to serious trouble both in the boilers and the prime movers. The corrosion trouble has shown a considerable increase of late years with the reduction in cooling surface per h.p. in modern condensers.

Extensive experiments were carried out with a view to:—

(1) Trying to obtain a condenser tube made of a metal which would stand up to the service conditions;

(2) Trying to find a means of forming a protective film which could easily be applied to the inside of a tube of the usual alloy.

The experiments along the first line gave fairly satisfactory, but not conclusive, results from tubes made up of an 85 per cent copper, 15 per cent nickel alloy, and of a 90 per cent copper, 5 per cent tin alloy. Out of 40 tubes made of each of these alloys the failures after twelve months' service were one and none respectively. During the same period 11 tubes out of 40 of a 70 per cent copper, 30 per cent

zinc alloy failed. Tubes made of a 70 per cent copper, 29 per cent zinc and 1 per cent tin alloy, tinned inside and outside, have also proved satisfactory, only six tubes out of 16,000 having failed after 12 to 15 months' use.

The second investigation led to the use of bitumastic solution sprayed on to the inside of the tubes so as to form a thin, even coating over the whole bore. A special sprayer was made for applying the solution. After spraying, a spiral hair brush was passed through the tubes in order to remove any surplus liquid, and the drying accelerated by means of fans. A second coat was then applied in a similar manner. The application of the coating to a condenser of anything between 3,000 and 6,000 sq. ft. surface takes six men about a week. The film appears to adhere best to tubes that have been slightly roughened by service, but even on smooth tubes is very tenacious.

The experiment has proved successful, as out of 10 condensers with a total of 28,500 tubes treated, only 21 tubes have failed. On examination of these it was found that the corrosion which had taken place before the tube was coated was such that it was impossible for the tube to last. The effect of the presence of the film, which is a poor conductor of heat, is to reduce the vacuum by one-quarter to one-half of an inch. In marine practice, however, this does not appear to reduce the efficiency of the propelling machinery as the effect is apparently counterbalanced by the increased cleanliness of the boiler surfaces.

Lightning and Electrical Circuits*

By C. S. Wright, A.M.I.E.E.†

The terms Lightning and Lightning Arresters were, until a few years ago, used only in connection with atmospheric electrical discharges and to denote devices for preventing such discharges from injuring electrical apparatus. The use of high potentials, however, has made it apparent that conditions can exist within a circuit itself, of which the effects are identical with many of those produced by atmospheric discharges. Thus, as far as electrical engineering practice is concerned the term Lightning Disturbances may be taken to include either external or internal disturbances.

Lightning, using the general acceptance of the term, is a phenomenon inseparable from the existence of an atmosphere containing aqueous vapor in suspension under temperature conditions which permit of the condensation of the vapor into drops. The condensation of vapor and the coalescence of small drops to form larger ones causes the accumulation and intensification of electrical charges carried by the vapor. Since the volume of a sphere varies with the cube of its diameter, while the electric capacity varies with the first power of the diameter, it follows that the charge caused by a drop increases with the square of its diameter. Expressed mathematically if n^3 drops coalesce to form one drop, the diameter of the latter is n times that of each little drop of which it is made. The charge caused by the drop is n^3 times as great as that carried by each smaller one, but the capacity is only n times as great. Therefore, as $n^3 \div n = n^2$, it follows that the potential is as the square of the number of drops. Since on first condensing, water vapor takes the form of very minute spheres, this doubling up process can, by the time the particles have agglomerated to the diameter of a healthy rain drop produce a very high charge. Lightning discharges from one part of a cloud to another part because this coalescence is by no means uniform in all parts of a cloud. The rate may depend upon varying temperatures, varying vapor densities (as shown by cloud color), air currents and possibly other causes, e.g., the presence of dust particles. A cloud, therefore, may contain charged drops of water at very different potentials. In addition to the potential gradients between different parts of a cloud there is an increase of potential from the earth upwards to the remote rarified regions of the air. The normal gradient is estimated at about 100 volts per ft., or about one-thousandth or one two-thousandth of the dielectric strength of dry air, the earth being negative to the air.

The potential differences between different clouds or between clouds and earth will give rise to discharges in the form of lightning. These are probably not simple sparks from end to end but consist of a series of discharges. An analogy of the unequal distribution of potential in a cloud and its effects is due to Steinmetz: Conceive a very irregular peaked heap of wet sand on a table; as the sand dries (not uniformly) the peaks crumble, thus starting small avalanches which communicate their motion to other peaks which also crumble. This goes on until a plane of relatively smooth sand is left. In the process some of the avalanches may slip off the table to the floor, by which is suggested a direct stroke from cloud to earth. It follows that we should not guess at the potential difference causing a lightning stroke by its length and the known breakdown (dielectric) strength of air—which is between 100,000 and 200,000 volts per ft. It is certainly far less than this.

Steinmetz gives some approximate quantitative values for the potential and energy of the average lightning flash as follow:—

Average potential gradient per ft. at moment of discharge (i.e. maximum 100,000 volts, minimum zero)	= 50,000 volts.
Average difference of potential between different parts of a cloud	= 50,000,000 volts.
Average current in discharge	= 10,000 amperes.
Average duration of discharge	= 1/500,000 second.
(The duration of the light is much longer owing to the time necessary for the heated path to cool off).	
Frequency of discharge	= 500,000 cycles per sec.
Energy of discharge	= 7,000,000 ft. lb. or 10,000 kw. sec.
i.e. the energy of a large turbo-generator for one second.	

Atmospheric lightning may affect circuits by: (a) direct stroke, (b) induction, (c) electrostatic charge. The effect of a is usually local and results in shattered insulators near the point struck. Such a disturbance cannot travel far owing to its steepness of crest. It probably always breaks down the insulators near where it strikes and its principal harmfulness lies in its liability to cause a short circuit or arcing to earth. In case b travelling waves of e.m.f. with respect to ground may be produced by lightning discharges between clouds and earth in the neighbourhood of a circuit. Such a wave may travel along a circuit of considerable length to a station containing highly inductive elements, such as choke coils and transformers. From these it is reflected back and forms peaks of high potential—being then a standing wave. Reflection of an electric wave builds up or dies down depending upon the self induction and electrostatic capacity of the circuit which it

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traverses. When, as in reaching a choke coil or transformer, the self induction is greatly increased the potential in the first few turns takes time to attain its maximum value. Having reached it, the wave has died down back of it on the line and consequently the wave starts back along the line. Choke coils are intended to act as reflectors which hold back the high potential waves until the lightning arrester between them and the line has time to divert the charge to earth. The peaks are much higher than the initial wave producing them—even as much as twice as high—and may break down insulators or apparatus unless diverted to earth through lightning arresters.

The electrostatic charge, referred to as case c, may be caused in a highly insulated system of conductors by a passing cloud, by an accumulation of charges from rain drops falling on the wires, or even by a difference in the natural potential gradient of the air at different levels over which the line passes. The static stresses are usually of little importance except that they may puncture insulation and cause short circuits.

External lightning can only affect circuits that are above ground, but internal lightning, i.e., extreme rises of potential with respect to earth and neighboring conductors, due to causes having no connection with lightning in the ordinary sense of the term, may cause trouble on all classes of circuit. The most dangerous high potential phenomena, and the most difficult to deal with, are the surges produced by an interrupted arc. An arc formed between conductors having considerable capacity is self rupturing, because the electrostatic capacity takes up the current necessary to maintain the arc. Further, the voltage necessary to maintain an arc increases as the current decreases, while an increase in voltage increases the static charging current of the system. This goes on until the arc is extinguished, when a surge of high potential is produced. The effect of the surge may be to start the arc again, if the arcing points are close enough, and the operation of forming and breaking the arc will continue with great rapidity. Such action sets up surges of comparatively low frequency which will travel long distances and are very destructive. This phenomenon is very important as it gives rise to a great deal of trouble. It may originate in some atmospheric effect or in a short circuit brought about by other means, and will continue until the protective devices clear the circuit. Other causes than quickly opening a circuit either by a single arc or an arcing ground will produce surges. Among them are, incorrect synchronising, rapid changes in load, and sparking over insulating surfaces.

In general the same means of protection are used against the effects of both external and internal lightning. All types of apparatus

operate on the lines of the original lightning rod in endeavoring to discharge the surge to earth. The complication in equipment arises from the fact that it is necessary to discharge the destructive surges from the circuit while preventing leakage of the useful energy normally carried. There are many types of arrester, as the devices for by-passing lightning discharges are termed, some of which have proved satisfactory for various classes of circuit. In general such services as telephone circuits and low potential d.c. lines may be efficiently protected by apparatus of the plain arc gap type. In the first instance a quite small gap between metal discs is sufficient, as there is no large amount of power normally in the line which would tend to follow the discharge to earth. In the second case a self-extinguishing gap with mechanical or magnetic means of elongating the arc will suffice. On constant current a.c. circuits, such as have been used for arc lighting, simple horn gaps are most suitable. The action is that the arc formed heats the air which therefore rises and elongates the arc until it is so thin and so much cooled that it goes out.

The principal trouble occurs on constant potential a.c. circuits such as are almost universally used for transmission of power. Arresters for such circuits may be of any of the following types:—(a) Horn gaps, simple or with non-inductive resistance in series; (b) multigap with resistance in series; (c) multigap with resistance in shunt to one or more sets of gaps; (d) electrolytic; (e) oxide film; (f) autovalve.

Horn gaps have the disadvantage of short circuiting the line for a considerable time, and this may so reduce the voltage of the system as to cause synchronous apparatus to fall out of step. They may also produce dangerous surges—like any other short circuit. Multigap arresters depend upon the cooling effect of sparking cylinders and upon their composition to extinguish the arc. Resistances in series with such gaps are not desirable as they oppose the passage of the discharge. They work well, however, with resistances in shunt but are incapable of living through the ordeal of continuous discharges caused by an arcing ground. The electrolytic or aluminium cell type of arrester has been much used but gives no definite advantages over the ordinary horn gap arrester with shunt or series resistance. The author has only observed one operation of an electrolytic arrester, which resulted from a heavy short circuit on an overhead line about a mile from the power house. In this case the arrester was totally destroyed. The oxide film arrester seems to offer advantages over the previous types. It has been used with good results on both high and low tension circuits and, although the life of the cell is not unlimited it is sufficiently long to make the

arrester fairly economical. The autovalve arrester, which is as yet scarcely developed gives promise of being very efficient. Its speed of operation is high and its life reasonably long.

But in spite of the research into lightning protection and the amount of money spent on apparatus there is still some doubt as to whether any lightning arrester gear is really beneficial. It would appear better policy to spend money upon an increased factor of safety for the apparatus to be protected than to seek increased protection by a multiplication of arrester gear.

The intensity of the induced effects of lightning is localised to a relatively short length of line in the immediate vicinity of the lightning flash. An analysis of statistics for several years shows that in those instances of failure of substation apparatus which have coincided with a lightning flash at a known point (identified by a failure of a line insulator) the distance of the flash, from the terminal of the line has not exceeded, and has generally been less than, one mile. It is also noticeable that failure of insulators on consecutive masts along a given route is of rare occurrence, which points to the fact that the

intensity of the induced effect falls away very rapidly as the surge passes along the line. It follows from this that the failure of line insulators must remain inherent to a system operating under the conditions generally experienced with e.h.t. power lines, and reliance must therefore be placed upon automatic discriminating cutouts to maintain uninterrupted supply. Even if it were proved that a particular type of lightning arrester would relieve its point of connection of dangerous strain, the line insulators could not be adequately protected unless such arresters were installed at frequent intervals, along every route. Such a procedure would involve very large expenditure, and would probably introduce much greater risk to supply than the lightning effect itself. Probably the best form of protection is that given by the use of earthed guard wires erected above and on either side of the power conductors. These reduce the risk of a lightning flash entering the conductors direct, and they certainly assist in damping out the intensity of high frequency surges passing along the line.

The Condenser Type Lightning Arrester for E.H.T. Lines

By Llewelyn Hughes, A.M.I.E.E.

Some engineers have come to regard the usual types of lightning arrester, such as the horn gap and electrolytic, as not altogether efficient for the work they are required to do. In order to justify its existence an arrester must be able to perform service under the following heads:—

- (1) Relieve the line of excess potential and high frequency potential;
- (2) Remove the power arc without the production of fresh surges;
- (3) Remain in good working order after a repetition of operations 1 and 2.

Recent practice on certain e.h.t. lines in Great Britain seems to show that the condenser type of lightning protection complies with the above conditions and gives the best service. The Merz and McLellan method of applying this protection consists of connecting the overhead lines to paper insulated cables before passing to the transformers. These cables provide a permanent path to ground of easy admittance to the high frequency surges, which are reflected from the end turns of the transformers. Experience with this method on two different electrical systems in the same area shows its value.

A certain colliery company in South Wales has 35 miles of 33,000-volt line forming a ring main. Lightning arresters of the usual type are not used, but a minimum length of 75 yd.

of three-core paper insulated cable connects the overhead lines to the substations. The substation transformers have a ratio of 33,000/11,000, and no switchgear is installed on the 33,000-volt side. Choke coils are installed on the line terminals and the lines are protected by the Merz Hunter system. These lines cross over several of the Welsh mountains but they have not been troubled by lightning effects, although other transmission lines in the same area have been damaged on several occasions.

Another company in the same district has five miles of transmission line arranged with similar lightning protection. Both ends of the line are connected to the respective stations through 100 yd. of three-core paper insulated cable, and the line terminals are provided with choke coils. Although the line was designed for 33,000 volts it has, up to the present, only been operated at 3,300 volts, and therefore is connected direct to the main switchboard of the power station. This line has been affected by lightning on three occasions, on two of which considerable damage was caused, but in each case the feeders supplying step-down transformers were not affected in the least.

On the first occasion a switch controlling a 1,500-h.p. winding motor, situated 400 yd. from the power station and connected through a three-core paper insulated single armored cable, was

destroyed, having flashed over a distance of 4½ in. at the back of the switch panel. In the second instance the stator coils of the 1,500-h.p. motor were burnt out and a 1,400-h.p. synchronous motor driving an air compressor suffered similar damage. In the third case the stator of a 6,000-k.w. generator broke down. The fact that the transformers suffered no damage from the surges on any of these occasions shows the efficiency of the condenser type protection.

Considering the experience of these two colliery companies with this type of lightning protection, it seems that transformers act as a choke to the high frequency surges, and offer certain protection against lightning disturbances. The transformers, of course, must be of robust construction. The writer believes that the above system of protection would be considerably improved by providing suitable reactances on all

circuits from the main switchboard, if overhead lines are connected thereto.

With internal surges, the forces depend on the power capacity of the system. One of the colliery companies mentioned has used reactances with advantage in the protection of certain circuits. Its generating plant has been increased from about 3,000 kw. to 52,000 kw. capacity within 20 years, and some of the earlier switches are not capable of breaking the circuit under severe fault conditions, with the present capacity of the system. After several serious breakdowns reactances for the protection of the circuits were installed and the results were very beneficial. It, in addition to the use of reactances, the main switchgear on large power systems is built with large breaking capacity, and a high standard of insulation is maintained throughout the equipment, damage from surges would be greatly reduced.

High Frequency Telephone Repeater

High frequency currents have been used for some time for telephone communication over power transmission lines, but a further advance in the use of such a vehicle for speech has been made in the designing of a repeater for use at interconnecting points. The Westinghouse Electric and Manufacturing Co. has installed the first repeating equipment at a substation where two generating stations are tied in, one by a 132 kv. line and the other by a 66 kv. line. The generating stations had previously been connected to the substation by high frequency telephone, but it had not been possible for the generating stations to communicate direct with one another. The power systems are electrically isolated insofar as the high tension lines are concerned, but the transmitting and receiving antennae at the substation now couple the two telephone systems.

The two frequency duplex system is used for the telephones. It is built up on the fundamental principle of employing one frequency to transmit and a different frequency to receive. The functions of transmission and reception are entirely separate, distinct and independent, and both functions may proceed simultaneously. Such simultaneous functioning is, of course, necessary in a repeater. In this particular case the repeater action was achieved without any drastic alteration to existing apparatus. The only thing required was the insertion of a suitable transformer between the output circuit of the high

frequency receiver and the speech input circuit of the transmitter, thus coupling the receiver output and transmitter input circuits together. By this means incoming signals or talk from either direction are applied directly to the transmitter. The latter, therefore, repeats what comes into it, both to the station which it is desired to reach and to the station where the signal originated. The operators at the two ends may interchange conversation with perfect freedom, that is, they may talk and listen, or both talk at the same time, if they care to, the operations being all cared for automatically. In addition, the operator at the repeater station may speak and listen, so that a three-party conversation may be carried on between the three operators.

The ease and simplicity with which this standard two frequency duplex system can be made to function as a repeater permits the more rapid extension of the system, since by taking advantage of its features extraordinarily long lines can be operated, and dissimilar systems, which are electrically isolated, tied together in a communication system. It offers a valuable means of getting by a break in a line; for instance, if a line is sectionalised at a point where a telephone set is installed, such a set can be converted into a repeater, and the break by-passed without loss in signal, and without resort to special coupling devices. In practice, there are numerous instances where an otherwise difficult communication problem is given a simple and complete solution.

Engineering Practice with the American Fleet

Electric Drive for Battleships

Perhaps the most interesting of the engineering features of the fleet of American warships which has just left our shores is the electric drive equipment of the most modern battleships. The first war vessel to be designed for electric drive was the U.S.S. Tennessee, which was followed by others of similar class. These battleships have a displacement of 33,000 tons, and are built for maximum speed of 21 knots. Their engine equipment consists in each case of two turbo-alternators which supply energy to four propulsion motors. The electrical method of power transmission is the most flexible that has yet been devised in that it gives the maximum ease of control, allows of very simple and rapid reversing and generally conduces to readiness of manoeuvring. In addition it allows of the most favorable disposition of the machinery for economy in construction and efficiency of protection.

The turbo-alternators are each rated to give an output up to 15,000 kv.a. at full speed. They generate at 3,400 volts three phase, 34.6 cycles at the full rotor speed of 2,075 r.p.m. The four propulsion motors are each rated at 7,000 h.p. normal full speed output, and each is direct coupled to a propeller shaft. They consist of two speed, wound rotor induction motors equipped with 24 pole and 36 pole independent stator windings. The normal maximum motor speed, 170 r.p.m., is obtained on the 24 pole connection. This connection is used for all speeds down to about 16 knots. For speeds from starting up to about 15 knots the 36 pole connection is used. Economy at these lower speeds is attained by running only one generator, but above 16 knots both generators are required. Speeds around 15 and 16 knots may be obtained with either the 24 or 36 pole connection and with one or two generators. Under test conditions the propulsion motors have developed a total of 28,000 shaft h.p. at 170 r.p.m. and 21 knots ship speed and 8,500 h.p. at 118 r.p.m. and 15 knots ship speed. Each motor, however, is capable of an output of 8,375 h.p. at 185 r.p.m. At full speed the motors operate at 95 per cent efficiency and 83.4 per cent power factor.

In addition to a main turbo-alternator, each engine room contains three 300-kw. geared turbo-generators, two condensing and one non-condensing. These machines supply direct current at 240/120 volts for excitation purposes, engine room auxiliaries and general lighting and power throughout the ship. The turbines run at 6,000 r.p.m. and the generators at 900 r.p.m. Steam for the main and auxiliary sets is supplied at 280 lb. per sq. in. by eight oil-fired boilers.

The control of the propulsion machinery is centred in a room located between the engine rooms and the motor rooms. The circuit breakers for all switching operations are interlocked so that wrong connections cannot be made. Liquid rheostats are used in the secondary circuits of the motors for bringing them up to speed. Remarkable rapidity of action in manoeuvring can be obtained with this type of drive as is shown by the fact that the vessel may be brought to rest from full speed ahead in three minutes and can be driven astern at a speed of 15 knots. The economy of operation from electric drive is revealed in statistics that show that plain turbine driven vessels have been found to consume between 20 and 48 per cent more fuel at various speeds than those of similar hull area electrically driven.*

Light Cruiser Propulsion Machinery

The light cruisers Omaha, Trenton, Richmond, Marblehead and Memphis are considered the fastest ships in the fleet. The last to be commissioned is the Memphis, which went into service in February, 1925, and therefore embodies the very latest practice in equipment. Her displacement is around 8,000 tons and her engines are rated at 90,000 h.p. On a trial run over 99,000 h.p. was developed, giving a speed of above 34 knots. The concentration of power in these comparatively small vessels is remarkable and is in marked contrast to the equipment of the battleships.

The engines are arranged in two separate rooms each containing two 22,500 h.p. Parsons type cross compound turbines with condensers and auxiliaries. Each turbine drives a propeller shaft through helical gearing with a four to one reduction. At full speed the propellers rotate at 385 r.p.m., so that the turbine speed is about 1,540 r.p.m. Steam at 265 lb. per sq. in. with no superheat is admitted to each high pressure turbine and expands in a uniflow direction, the thrust being taken by means of a Kingsbury ball thrust bearing. The exhaust from the high pressure turbine is led to the centre of the low pressure cylinder which is of the double flow type. From this the exhaust is taken to a surface condenser. Each turbine rotor drives a pinion and the two pinions of a set are geared on opposite sides of a single spur wheel which drives the propeller shaft. The machinery is so arranged that the turbines in the aft engine-room drive the inboard shafts while those in the forward room drive the outboard.

*For further particulars of electrically driven battleships see the "Commonwealth Engineer," May, 1925.

In addition to the main turbines each engine-room has a cruising turbine for propelling the ship at low speeds. The cruiser in the aft engine-room drives a shaft on the port side while that in the forward room drives a starboard shaft in order to maintain balance. These turbines are of quite small power and are only designed for driving the vessel up to a maximum of $17\frac{1}{2}$ knots. Their purpose is to maintain reasonable efficiency which could not be done if the main turbines were revolved at slow speed. The gear ratio of the cruising turbines is 40 to one so that when the propellers are driven at their maximum cruising speed of 100 r.p.m. the turbine is doing 4,000 r.p.m. The drive is transmitted through a clutch and gears to the shaft of the high pressure turbine and thence to the main gearing. The exhaust steam from the cruiser is led to the low pressure cylinder of the main turbine so that both pinions transmit the power drive. The clutch is interlocked with the throttle of the cruising and main turbines so that the cruising turbine cannot be started unless the clutch is engaged and the main turbine throttle closed, and the main turbine cannot be started unless the clutch is disengaged and the cruising turbine throttle closed. The usual cruising speed of the vessel is around 12 knots, and at this speed the effective range without re-fuelling is about 12,500 miles.

Astern running is attained by admitting full pressure steam to special blading at the rear end of the low pressure cylinders of the main turbines. Although only moderate speed can be attained astern a fairly high power is developed as will be realised from the result of a test when the vessel was pulled up from full speed ahead and commenced to make way astern in one and a half minutes.

The main condensers are furnished with brass tubes each rolled into the tube plate at one end and with the other end packed with Crane metallic packing. This allows for expansion and has been found very satisfactory in practice. Corrosion is effectively dealt with by keeping a supply of zincs at the end of the condenser where the circulating water enters. The zincs corrode rapidly and require renewal about once a month but the tubes give no trouble. The circulating water is supplied at ship speeds up to 10 knots by a steam turbine driven centrifugal pump running at 3,000 r.p.m. At above 10 knots the ship has sufficient way to take up circulating water automatically through special scoops projecting slightly from the hull. This method naturally gives a quicker circulation as the speed of the vessel increases. The wet air pumps are steam driven, of the reciprocating type, and maintain a vacuum within half an inch of the barometer.

Forced lubrication for all turbine bearings, for the gears and for the oil governor control is

supplied by means of steam driven oil pumps. An ingenious device has been fitted to all main bearings consisting of a small brass cup on top of which is a butterfly vane. This vane rotates when the oil is flowing properly. If the flow ceases the vane stops moving and thus gives a visual indication of the state of the bearings. In addition, should the oil pressure fall below a certain value a warning whistle blows.

A new and rather unusual device is used in connection with the glands of the turbines. This is known as a gland exhauster and its function is to collect the steam which has passed through the sealing glands and would otherwise escape to atmosphere, condense it and return it to the hotwell. It consists of a small exhaust fan, driven by a half h.p. motor, and a small surface condenser. The fan is piped to all the glands and passes the exhaust steam through the condenser. The condensate drains away by gravity. Some idea of the economy effected by this simple piece of apparatus may be gained from the fact that the condensate from the glands of each turbine runs as a $\frac{3}{8}$ in. stream of water while the vessel is at sea. In addition the increased comfort to the engine room staff through the elimination of exhaust steam from the atmosphere is a considerable advantage.

In addition to the main turbines, each engine room contains two 100-kw. geared turbo-generators. The turbines of these run at 7,200 r.p.m. and the generators supply current at 120 volts d.c. The two generators in each room may be paralleled but it is not possible to parallel the generators in the aft engine-room with those in the forward engine-room. The generator and distribution boards consist of ebony asbestos wood panels mounting air break circuit breakers, knife switches, fuses and meters. Two generators are sufficient to supply the whole load of the ship, providing energy for the steering gear, ventilation blowers, fire room blowers, electric winches, gun turrets, searchlights, arc generator for the radio transmitter, general lighting and miscellaneous power. A battery of Edison cells is also charged from these generators, to provide emergency lighting in case of a shut down.

Ventilation for the whole ship is provided by means of electric blowers. In the case of the engine rooms the system is particularly complete. The air is introduced through two main trunks and distributed through branch trunks to all parts of the room. Each branch trunk carries an adjustable mouthpiece so that the air may be directed as required. The exhaust air rises through a special funnel and escapes to the deck.

The vessel carries 12 boilers arranged in batteries of three each in four separate fire rooms. The boilers are of the water tube type with $1\frac{1}{8}$ in. tubes and are oil fired. There are 14 burners to each boiler, 12 of the ordinary type and two of the Mayflower type with integral

blowers. This latter type has a great advantage in that the blowers do away with the necessity for air-locking the fire rooms and working at high atmospheric pressure. The two burners to each boiler are sufficient to keep steam up while in port, but when the vessel is under way more burners are required and it is, of course, then necessary to seal the fire room and operate under pressure. Under these conditions air is supplied to each room by an electrically driven blower which operates up to a water gauge of $7\frac{1}{2}$ in. The draft is regulated by speed control of the blowers.

The oil is supplied to the burners by means of steam driven reciprocating pumps at a pressure of 250 lb. per sq. in. and preheated by exhaust steam to 160 deg. F. In addition to the force pumps for oil there is a booster pump which is operated if necessary to draw the oil from the storage tanks in the ship's bottom. The tanks have a capacity of 450,000 gal. They are provided with steam heating coils for reducing the viscosity of the oil if necessary, so that it may be pumped. Exhaust steam is used for all heating purposes including feed water heating. The feed water enters the boilers at an average temperature of 230 deg. F. In case of necessity it is possible to run the boilers up from banked to full steaming in about 12 minutes.

Fresh water for all purposes in the ship, including make up feed, is supplied by two units of double effect evaporators operating on exhaust steam at about 8 lb. per sq. in. pressure. The vessel also carries a refrigerating plant which operates on CO₂ gas and calcium chloride brine. There is also a compact machine shop where ordinary repairs can be carried out. This contains an 18 in. gap lathe, a 14 in. lathe, a large drill and a high speed sensitive drill, a milling machine, a shaper and a power saw. Large jobs, however, which cannot be handled in this shop have to be passed on to a repair ship.

Repair Ships

A typical supply and repair ship, attending to the needs of the fleet on long voyages, is the U.S.S. Melville. This vessel serves 18 destroyers, carrying complete stores and having provision for doing any repair except one needing dry-docking. Indeed it can almost do this for it carries spare propellers which can be fitted at sea by the use of a special caisson which attaches to the stern of the destroyer. Amongst the stores carried are supplies of food and clothing, engineering requisites including screws, bolts, small tools, etc., pipe, sheet, bar and angle iron, electric wires and cables, electrical accessories, and moving picture films. The vessel also carries a considerable store of petrol, in steel tanks, for supplying the power boats of the fleet.

Most of the machinery is electrically driven, the chief exceptions being the anchor engine and the towing engine. The former is a compound

reciprocating steam engine which drives through gear and clutch to any of the three anchor chains. The towing engine consists of a large winch at the stern of the ship, by means of which a disabled vessel may be brought to port. The engine is equipped with compensating gear which takes up the slack of the towing cable in a heavy sea and prevents undue straining. All the winches for hoisting material are equipped with electric motor drive. Electricity is used also in the galley in such equipment as an automatic potato peeler. There is also an electrically equipped bakery with three ovens and a dough mixer. In the laundry there is an electric washing machine, centrifugal dryer, mangle, steam presser, steam heated dryer, and several electric irons. The galley stoves are not electric, being oil fired.

For guarding the health of the personnel of the fleet there is a dental surgery with two chairs, and a hospital with well-equipped operating room. There is also a barber's shop with two chairs. The ventilating system of the vessel includes air heaters for maintaining an equable temperature under adverse climatic conditions. The boat equipment includes six motor boats and four speed boats. For purposes of defence eight 5 in. guns and one 3 in. anti-aircraft gun are carried.

The repairs section of the ship includes a foundry with iron cupola and two oil-fired brass furnaces where castings up to one ton weight may be made. There is also a blacksmith's and sheet metal worker's department with two oil-heated forges, bending blocks, and steam hammer capable of forging 8 in. stock. Provision is made here also for the re-babbiting of bearings. There is a well equipped wood working shop with power saws, planing machine, etc., with which is incorporated a pattern making department. An electrical repair shop provides for armature winding and general maintenance of motor drives, etc. Complete oxy-acetylene welding and cutting equipment is carried, along with a large stock of oxygen and acetylene in cylinders stored on deck.

Perhaps the most interesting feature of the vessel, however, is the machine shop, which in point of equipment and scope of work rivals many a first class shop on land. There are 16 lathes, ranging from an 8 in. Rivett precision lathe to a gap lathe with 60 in. face plate, which is capable of being opened out to take a 22 ft. job between centres. There are also a 26 in. and a 24 in. vertical turret lathe. There are six drilling machines of various sizes and one radial drill with 42 in. radius, a 24 in. and a 16 in. shaper, a planer with 9 ft. stroke, two horizontal boring mills, a power threading machine, one Fosdick and one Cincinnati universal grinder, a Brown and Sharpe tool and cutter grinder, three emery grinders taking up to a

12 in. x 2 in. stone, and a buffing machine. Further, there are three Milwaukee universal milling machines with spiral gear attachments and universal head, and three arbor presses with 8, 12 and 16 in. stroke respectively. A very complete stock of tools is carried so that the shop can cope with every emergency. This is particularly noticeable in connection with the milling machines for there is a remarkably fine stock of cutters. Every machine is equipped with all necessary attachments. One miller has a circular table, and two of them have slotting heads. The lathes are equipped with two and three jaw chucks, universal chucks, face plates, tapering attachments, etc. Individual motor drive is used throughout, partly because of its efficiency but principally because the low head room and value of space will not permit of the use of shafts and belting. But although space is valuable there is no crowding, and ample room is allowed for working each machine.

The repair ship *Medusa*, which is attached to a battleship squadron, carries very similar mechanical equipment to the *Melville*, but on a

larger scale. There are three cupolas in the foundry of this vessel and castings up to three tons weight may be made. There is also a 40-ton crane on board to facilitate the handling of heavy parts, and a three-ton travelling crane. In the blacksmith's shop is a combined steam and hydraulic press of 150 tons capacity. In contrast to these heavy material departments is the instrument section where periscopes, range finders, binoculars, watches, etc., may be repaired and adjusted. There is also an electro-plating shop where parts such as searchlight mirrors may be plated and polished. One section is devoted to aviation, where the seaplanes may be overhauled and repaired. The vessel is of 10,500 tons displacement and her armament includes four 5 in. guns and two 3 in. anti-aircraft guns. Although she is really a repair ship she is also a technical school where men may receive a thorough training in engineering and naval technique generally. The necessity for these repair ships arises from the large radius covered by the American fleet and also from the desirability of being independent of outside workshops.

THE LATEST WORD IN ELECTRIC SHIP PROPULSION

The U.S.S. *Saratoga*, the giant aircraft carrier for the United States navy, which was launched in April last, has the most powerful electric drive equipment that has yet been installed in any ship. The vessel was originally intended for a battle cruiser, being one of six of a class to be built under the 1916 programme. Under the arms limitation treaty, however, she was converted into an aircraft carrier along with her sister ship, the *Lexington*, which will soon be launched.

The ship is in many respects unusual. Her overall length is 874 ft., her beam 105 ft., and she is capable of a speed of 33 knots. Her upper deck is designed as a landing and taking-off place for aircraft and is, therefore, built without any obstruction to its sweep except for a single smoke stack and the navigating bridge. The propulsion machinery consists of eight 22,500 h.p. electric motors coupled in pairs to the four propeller shafts, so that the total shaft horse power of the vessel is 180,000. These motors are supplied with energy from four 40,000 kv.a. turbo-alternators. The turbines are of the Curtis type, 13 stage, and run at 1,775 r.p.m. The generating voltage is 5,000. Steam is supplied from 16 oil-fired boilers. In addition to this propelling machinery the vessel will carry six 750-kw. turbo-generator sets, furnishing direct current for auxiliary purposes, lighting and general power supply.

WORLD'S LARGEST TURBO-ALTERNATOR

An order has just been placed by the Brooklyn Edison Co., New York, with the Westinghouse Electric and Manufacturing Co. for the largest steam turbo-generator yet ordered anywhere in the world. This unit, which is for the new Hudson avenue generating station, will have a rating of approximately 100,000 kv.a., or more than 50 per cent in excess of the central station company's 62,500 kv.a. unit, also at Hudson avenue, which is now the ranking machine for size. The cost of the new machine will be in the neighborhood of a million dollars. It will be of the cross-compound type, 67½ ft. long, 36 ft. wide and 24 ft. high. The entire unit will weigh 830 tons. The largest single piece, the low-pressure cylinder cover, will weigh 78 tons.

Steam will enter the high pressure turbine at 375 lb. per sq. in. and 700 deg. F. The steam consumption rate will be slightly over nine pounds per kw. hr. With four-stage bleeding the machine will produce a unit of electricity at a little under 11,000 B.th.u. The rotors will revolve at 1,800 r.p.m. and the generator voltage will be 13,800. The generator cooling is to be of the recirculating type, with air coolers using condensate and well water.

During the year 1924, Canada exported 1,396,521,724 kw. h. of electrical energy to the United States. This business is carried on under licenses issued from year to year. The Canadian budget for the year 1925-1926 proposes a tax of 1.95 dollars per h.p. per annum on the export of energy.

The Virginian Electric Locomotive

The first of the locomotives for the electrification of the Virginian railway in U.S.A. has recently been completed by the Westinghouse Electric and Manufacturing Co. The contract under which it was built calls for 36 motive power units and the normal locomotive consists of three of these units semi-permanently coupled together. The assembly constitutes the largest and most powerful locomotive yet built. The necessity for such a powerful tractive machine has been brought about by the heavy grades on a section of the Virginian railway. The line

Energy for the electrification will be supplied over 88,000-volt transmission lines from a steam plant in course of erection at Narrows, Virginia. The trolley system is 11,000 volts single phase, but the equipment has been designed to provide for an increase of voltage to 22,000 if required.

The complete three-unit locomotive weighs 570 tons, is 152 ft. in length and exerts a maximum tractive effort of 277,500 lb. It will operate at constant running speeds of either 14 or 28 m.p.h. and develop a maximum of 7,125 h.p. Each unit has the Mikado, or 2-8-2,



Steam Pusher Locomotive and New Electric Locomotive for Virginian Railway, U.S.A.

was built for the purpose of moving coal from the New River and Pocahontas fields to tide-water at Norfolk, and it has operated successfully for many years with steam traction. Increasing traffic, however, has taxed the steam locomotives on the heavy grades to their utmost capacity and brought about such a condition of affairs that electrification became necessary in order to preserve efficiency. A £3,000,000 contract was therefore placed for the electrification of 134 miles of route, comprising 213 single track miles. Such progress has now been made that it is expected that complete electric operation of the section will be commenced before the end of 1925.

wheel arrangement and the driving axles are coupled in pairs to two jackshafts by means of side rods. Each jackshaft is driven by a motor, through flexible gearing, the total ratio from motor to wheel being 21 : 100. Energy from the 11,000-volt single phase trolley is taken to a main oil-insulated, force-cooled transformer and stepped down to a suitable voltage to pass through a phase converter. This machine provides three phase current at a pressure suitable for the motors. The control is of the electro-pneumatic type. Acceleration to the running speeds is obtained by varying the resistance in the rotor circuit of the motors by means of a liquid rheostat. Regenerative braking is used

when descending grades. The control is arranged to permit of four units being operated together if future traffic requirements warrant such operation.

Under steam operation 5,000-ton trains were moved up the heaviest grade by means of a 2—8 + 8—2 road engine and two 2—10 + 10—2 pusher engines at a speed of about seven miles per hour. The combined weight of locomotives in this train was 1,130 tons and the combined tractive effort 409,400 lb. With electric operation two three-unit locomotives, one at the head of the train and one as a pusher, will handle 5,400-ton trains at a speed of 14 m.p.h. On the high speed connection each electric locomotive can exert 6,000 h.p. continuously, a power far in excess of that possible with a steam locomotive. The tractive effort of the electric locomotive is 31 per cent greater than that of the steam pusher locomotive.

While the Virginian electrification is a huge undertaking and has many outstanding engineering features, its greatest significance is in the economic aspect. The electric locomotives are cheaper to run than steam locomotives, for their inherent maintenance expense is in no way comparable. In addition, the cost of electric power is less than the cost of coal for locomotives, due to the more efficient burning of the fuel in the power house. Further, there are no standby losses in the electric locomotives, although the reduction in power costs is largely offset by the maintenance and depreciation of the transmission and distribution system. Electrification has been proved to be the only solution of the problem of economically handling dense railway traffic. The case of the Virginian railroad points to electricity as being able to carry on when steam can no longer contend with heavy grades and increasing loads.

Electrification of the Southern Railway, England

A considerable amount of interest has been aroused by the electrification scheme now being carried out on the suburban sections of the Southern Railway. When completed it will mean a greatly improved service of trains between the populous suburbs and the great London termini of the line. The complete electrical equipment for the 21 motor coaches, 60 driving trailer coaches, and 20 non-driving trailer coaches has been supplied by the General Electric Co. Ltd., Witton. The electrical system employed is 25 cycles, single phase, and this, coupled with the fact that many new features have been embodied in the design and layout of the apparatus, gives considerable interest to the equipment.

Each train is built up on the multiple unit principle, one motor coach being provided for each train unit which contains all the electrical apparatus required; that is, of course, apart from control equipment on driving trailer coaches, control lines, lighting equipment, etc. The motor coach contains no accommodation for passengers, the space apart from that occupied by apparatus being allotted for the guard's van. It can be controlled from both ends, so that in effect it becomes almost a locomotive, more particularly as it can be used for running in either direction at either end of a train without need for turning round; also it can be used for hauling ordinary non-electrical coaches usually hauled by steam locos. The make-up of a train unit at present consists of five coaches, the motor coach being in the middle with three driving trailer coaches and one ordinary trailer coach. The provision of an additional driving position is for flexibility in train formation. Naturally this make-up can

be varied to suit traffic conditions; during the rush hour periods two 5-coach trains are coupled together.

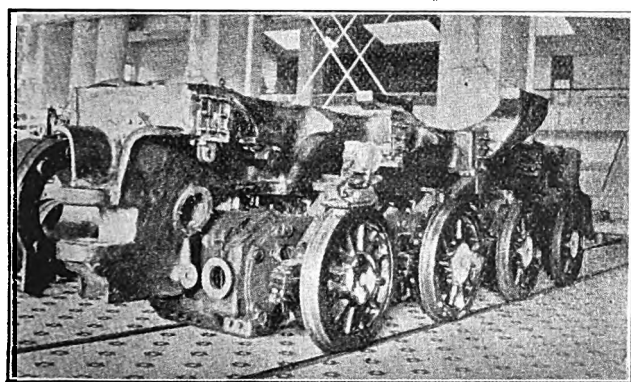
The equipment of a motor coach is duplicated at each end with the exception of the air compressor. The arrangement of the gear in this way is of great value in case of a fault in one section, as the coach can still be operated by the other. The equipment for each section consists essentially of bow collecting gear, main and auxiliary transformers, two motors, together with the necessary switch and control gear which is of the "all electric" type. The main transformer, auxiliary transformer, and preventative coil are all contained in an oil tank which is cooled on the outside by forced draught from a blower unit. As already stated, there are two motors per section, i.e., four in all. They are of the single phase series compensated type with interpoles and self ventilated; external forced ventilation is also provided from the motor driven blower. The maximum continuous specified rating of each with external forced ventilation is 200 b.h.p. at a speed not exceeding 34.7 m.p.h.

The lay-out of the whole scheme and the preparation of the specifications were carried out by Sir Philip Dawson, K.B.E., M.I.C.E.

It has been stated that, owing to the attitude of the present government of New South Wales in regard to the proposed subsidy, there is a possibility of the Jackadgery hydroelectric scheme being abandoned. The latest advice, however, indicates that the scheme will probably be pushed ahead.

The Ford Electric Locomotive*

Henry Ford, who has a reputation for doing the unusual, is building what will be one of the largest and most powerful locomotives yet constructed. Not only are its proportions unusual, but it is of a type which is as yet comparatively new to practice. It will receive energy from a single phase high tension trolley and convert it to d.c. for actuating the motors, thus taking advantage of the economies of a.c. transmission and the excellent operating characteristics of d.c. traction motors. The electrical equipment is the product of the Westinghouse Electric and Manufacturing Co., the mechanical parts were designed by engineers of the Ford Motor Co., and the locomotive is being built at the Highland Park works of the latter company.



Truck for Motor Generator Unit.

The locomotive is to be used for freight service on the Detroit and Ironton electrification of Mr. Ford's railroad.

The machine is divided into four sections, two sections comprising a unit. The first and fourth will each carry a transformer, control apparatus, air compressor, batteries, etc., and the second and third will each mount a motor generator. Each section will be supported on eight driving wheels, with a motor geared to each axle. Both units, comprising a transformer and a motor generator section, will be arranged for double end operation, so that they may be used separately if desired. Each unit will weigh 170 tons. The locomotive will develop a maximum of 5,000 h.p. at 17 m.p.h., and will exert a maximum starting tractive effort of 225,000 lb. on the basis of an axle loading of 42,500 lb. at 33½ per cent adhesion. The normal rating of the locomotive will be 4,200 h.p. It will also deliver 3,600 h.p. continuously at all speeds between 17 and 25 m.p.h., and will exert 54,000 lb. tractive effort continuously when operating at 25 m.p.h.

The motor generator type of locomotive has many advantages. Those already mentioned are the economy of the high voltage a.c. transmission direct to the locomotive without the intervention of stationary substations, and the excellent operating characteristics of the d.c. motors. Amongst the further advantages are the simplicity and flexibility of the control, the simplicity of the regenerative system, the absence of rheostatic losses, the low accelerating peak loads, the constant h.p. characteristic, ability to maintain the a.c. at unity p.f., and small tendency to wheel slip. In short, the design is considered to furnish the most flexible and at the same time the most reliable traction power unit yet evolved. The equipment and operation of each unit is as follows:—

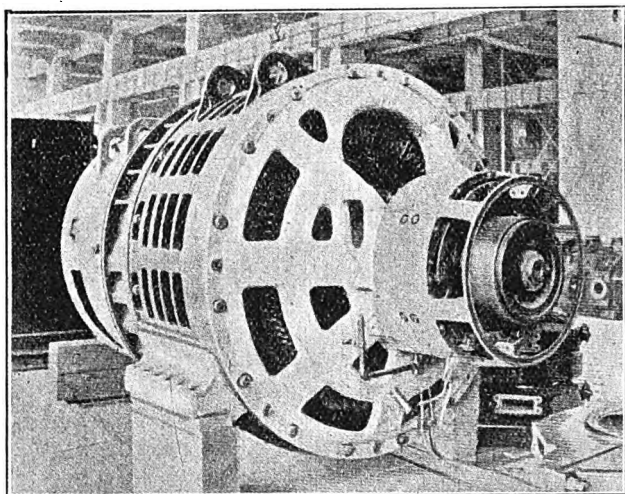
Single phase 25 cycle a.c. energy will be collected at 22,000 volts from the overhead system by means of a pantograph, and conducted through an oil circuit breaker to the primary side of a 2,000-kv.a. two circuit, oil insulated, air cooled transformer. The high voltage side of this transformer will be connected between the circuit breaker and ground in series with two s.p. double throw knife switches in such a way that the windings can be connected to operate on either 22,000 or 11,000 volts as desired. This feature has been included so that the units may be operated over 11,000 volt lines if required. The secondary of the transformer will deliver current at 1,250 volts.

The motor generator set will consist of a 2,100 h.p., 25 cycle, four-pole, single phase motor, driving a 1,500 kw., 600 volt, 2,500 amp. generator at 750 r.p.m. The set will be a self-contained machine supported at three points, and will comprise two bearing brackets, with suitable bearings, motor stator, a generator field, and a shaft carrying the generator armature and the motor rotor. A 75 kw., 125 volt, d.c. main exciter will be mounted directly upon a shaft extension at the motor end of the motor generator set, and a 25 kw. d.c. regenerative exciter will be mounted directly upon a shaft extension at the other end. The generator will be provided with series-excited differential field, interpole field and compensating field as well as a separately excited field. The main exciter will be used to supply excitation to the motor field, the generator field, regenerative exciter field, and to supply power for all auxiliary motors and for the control circuits. The regenerative exciter will be used to separately excite the traction motor fields during the regenerative period and during high speed motoring periods.

Since the single phase driving motor of the main motor generator set is not self-starting, the set will be started and partially accelerated

*Westinghouse International.

up to speed from the direct-current end. A 60 cell, 125 volt storage battery will be provided on each unit for this purpose. This battery will be used further for energising the control circuits and supplying power to the compressor motor whenever the motor generator set is shut down. The set will be accelerated to approximately 50 per cent of its speed by means of the main generator and from 50 per cent speed to full speed by means of the a.c. motor.



Motor Generator Set

The traction motors, of which there are eight per unit, are 225 h.p., 600 volt, d.c. series, axle-hung machines. They will be connected permanently in parallel on the electrical side. Each motor will be connected flexibly to a driving axle by double gearing, i.e., with a gear at each side. A 22 tooth, $3\frac{1}{2}$ in. face, 3 d.p. pinion, suitable for meshing with a corresponding 98 tooth gear will be mounted on a shaft extension at each end of the motors.

Starting from rest with a full tonnage train, the traction motors will be energised as series-excited motors and the train may be accelerated up to a continuous full tractive effort running speed of approximately 17 m.p.h. by manually regulating the main generator voltage by means of an external field resistor and a set of 50 amp. 125 volt switches. If desired, and if load and grade conditions permit use of a higher running speed than is obtainable with the series connections, a closed-circuit transition will be made from the series connection to the separately excited connection of the traction motors. The speed may then be increased by weakening the field strength of the traction motors. This will be accomplished by manually regulating the regenerative exciter voltage through an external field resistor and a set of 5 amp. 125 volt switches.

When the train passes over the crest of a hill and it is desired to maintain a certain

constant speed while descending the grade, the traction motors will be made to act as generators by strengthening and properly regulating their fields. Speed may be decreased to approximately 17 m.p.h. by properly regulating the traction motor field strength, which speed may be further lessened by regulating the generator voltage. Air braking equipment for bringing the locomotive to rest is provided on six of the eight wheels of each section.

An idea of the flexibility of control of this type of locomotive may be obtained from the fact that 45 normal running speeds will be available between standstill and maximum speed during both the motoring and regenerating periods. These speeds are obtained without any main rheostatic losses. On the contrary, during regeneration the locomotive will return power to the line. Thus remarkable operating economy may be expected.

ELECTRIC LOCOMOTIVE EQUIPMENT

The English Electric Co. Ltd. has published an attractive bulletin of 20 pages descriptive of the equipment and general arrangement of a typical electric locomotive manufactured in their shops. The unit described is equipped with four 350-h.p. motors and operates on standard gauge lines from a 1,500-volt d.c. trolley. A general description of the principal parts of the equipment is given, accompanied by numerous illustrations, diagrams of connections and a general arrangement drawing of the complete locomotive. A list at the end of the volume shows that the total power of locomotives built by the company to date is 235,580 h.p. The largest orders have been received from the Chemins de Fer du Midi, France, totalling 110 locomotives and from the imperial Japanese government railways, 36 locomotives.

The complete programme of electrification for the Midi railways includes the construction of about 400 locomotives and a large number of motor coaches. Each locomotive is of the four axle type, with total weight of 72 tons and rating of 1,400 h.p. In addition to these, two express locomotives rated at 2,100 h.p. and capable of speeds up to 75 m.p.h. have been built. The motor coach equipments have a rating of 700 h.p. and each complete car weighs 50 tons.

Of the locomotives for the Japanese government 26 are of the four motor type and eight have six motors. The weight of each of the former is 59 tons and its rating 1,224 h.p. The latter are for high speed passenger service and are of the 4-6 + 6-4 type. Each weighs 98 tons and is rated at 1,836 h.p. The gauge is 3 ft. 6 in.

Phasing-Out Transformers

The following note describing a practical problem and its solution has been submitted by a reader of the "Electrical Engineer." As the function of a technical journal is to assist in the interchange of ideas, notes of a similar nature will always be welcome.—Ed. E.E.

Two transformer banks, each of three single phase subtractive polarity units were connected to the same high tension mains as shown in Figs. 1a and 2a. In each case the low tension leads were arbitrarily marked $r\ w\ b$, as indicated, without any reference between the banks. Occasion arose for the transference of the load from No. 1 to No. 2 bank and the only possible connection was r to r' , w to w' , and b to b' . The problem was: would the phase rotation of the load be the same after the change as before?

Since No. 2 bank is connected to the same h.t. mains as No. 1, the vector diagram for the h.t. side of No. 2 bank must be the same as that for the h.t. of No. 1 bank. Thus we get Fig. 2b identical with Fig. 1b. Fig. 1c, the vector diagram for the l.t. side of No. 2 bank, is then obtained by drawing, in this case, $r'n'$ parallel to but opposite to $B'R'$, $w'n'$ parallel to but opposite to $R'W'$ and $b'n'$ parallel to but opposite to

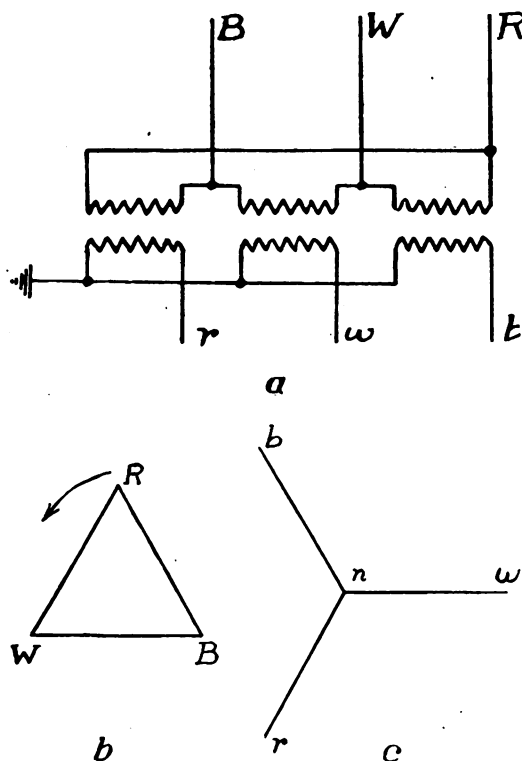


Fig. 1

Investigation disclosed that the phase rotation was the same, but that the two banks of transformers could not be paralleled on these connections. The procedure in ascertaining the right connections was as follows:—

Assuming the vector diagram for the h.t. side in Fig. 1a as given by Fig. 1b, the vector diagram of the l.t. side can be obtained by drawing $r\ n$ parallel to but opposite to $R\ W$ (since the transformers are subtractive), $w\ n$ parallel to but opposite to $W\ B$ and $b\ n$ parallel to, but opposite to $B\ R$. Fig. 1c, obtained thus, gives the phase rotation of the l.t. side.

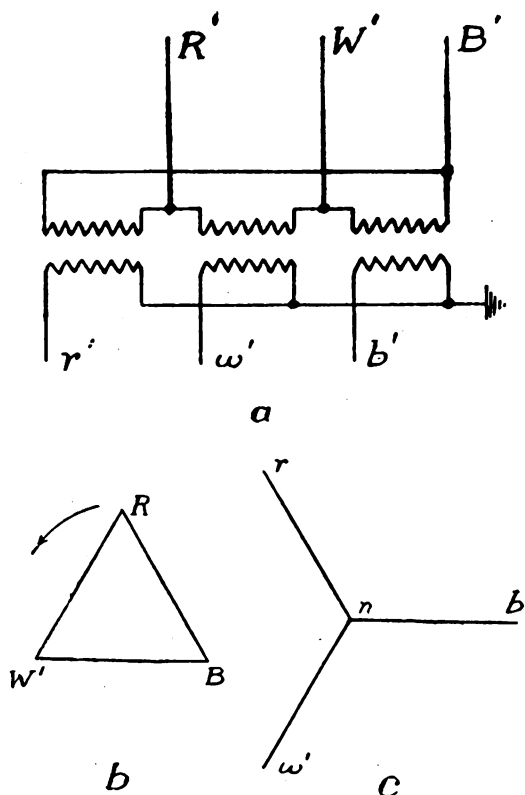


Fig. 2

$W'B'$. Comparison of Fig. 1c and Fig. 2c shows that the phase rotation is in the same direction in both cases. Superimposing Fig. 2c on Fig. 1c the two systems are shown to be in phase, but r' corresponds to b , w' to r and b' to w . Therefore if these connections are made the two systems can be paralleled.

A similar problem arises again when it is necessary to parallel two three-phase transformers one of which has subtractive polarity and the other additive. At first glance such paralleling may seem impossible but treatment similar to that described will overcome the difficulty.

ELECTRIC LOCOMOTIVE TYPES

In a paper on the Development of the Electric Locomotive read by Mr. F. H. Shepard, of the Westinghouse Electric and Manufacturing Co., before the American Railway Association, the principal features of various types of electric locomotive are described. It is noteworthy that except for purely local conditions which prevail for some services, the use of low voltage d.c. for the supply system is not now given practical consideration. The three phase system also is not much used owing to the complication of overhead gear, and limitations of voltage. The principal systems in present use are d.c. at 1,500 to 3,000 volts and single phase a.c. at 11,000 to 22,000 volts. Of these the a.c. system is the better where feeding distances are long and loads are heavy.

As far as motor equipment is concerned the d.c. series and the a.c. three phase give the best performance. The former, however, cannot give its best results for heavy work on a medium voltage d.c. overhead system owing to the limitation mentioned above, but it will give excellent operating characteristics on a locomotive of the motor-generator type taking current from a high tension single phase contact wire. Such a system gives a wide range of speeds and allows of very simple means of control for both motoring and regeneration. Rheostatic losses are practically eliminated, and the use of a synchronous motor on the motor-generator set allows of control of power factor.

The three phase induction motor can only be used under the best conditions in a system somewhat similar to that described for the d.c. motor. Current may be supplied from a high tension single phase overhead wire, through a phase converter carried on the locomotive. It is practically a constant speed motor but additional speeds may be obtained through varying the number of poles or by cascade connections between motors. In freight service, however, for which the type has many advantages, it is seldom necessary to have more than two speeds. Acceleration is accomplished by varying the external resistance in the motor secondary circuits. Very high starting torques are obtainable with this type of motor, as well as ability to carry heavy loads. A further advantage is that regeneration is obtainable automatically, without additional apparatus for switching. separate excitation or regulation of any kind. The motor automatically becomes a generator whenever the locomotive, while descending a grade, exceeds the synchronous speed. Such motors are particularly adaptable for heavy service where constant speed is desirable, because of the simplicity of the control and for the attainment of the highest weight efficiency with large motors.

Types of drive vary very widely and a great many devices have been adopted in order to overcome trouble arising from the relative movement of the locomotive frame and axle. Of the individual drives, probably the simplest is obtained by the use of axle hung nose suspended motors with single reduction gearing. Certain advantages are also claimed for the quill type of drive and various flexible geared drives. In general for large powers and high speeds some form of collective drive, involving the use of side rods, is used. The best forms of these involve the use of a jack shaft, either direct driven or geared. In general it may be said that in all respects, whether in motor equipment, drive or general arrangement, the design of an electric locomotive calls for some compromise or balancing of conditions.

ELECTRIFICATION CHANGE-OVER

The Cascade tunnel electrification of the Great Northern railway in the United States is being changed over from three phase to single phase and d.c. The original system used two trolley wires at 6,600 volts, with three phase induction motors. This will be replaced by an 11,000 volt single phase wire supplying power to motor-generator locomotives. The Westinghouse Electric and Manufacturing Co. has received the order for the necessary substation and overhead equipment and for two two-cab motor generator locomotives. In addition a phase converter equipment, mounted on a tender, is to be supplied. This will be used to convert from single to three phase power so that two of the four existing three phase locomotives may still be used.

SYDNEY RAILWAY ELECTRIFICATION

Provided necessary funds are made available the New South Wales railway commissioners anticipate the completion of the railway electrification by 1930, thus synchronising with the construction of the Sydney harbor bridge. Approximate dates of the commencement of electric train services are as follow:—Hurstville to Sydney, December, 1925; Sutherland to St. James station, June, 1926; Bankstown line, July, 1926, complete service, January, 1927; M. on's Point to Hornsby, January, 1927, complete service January, 1929; main suburban to Homebush, July, 1927; complete service, January, 1929. Homebush to Liverpool, via Regent's Park and Bankstown-Regent's Park, January, 1929, complete service, April, 1929. Homebush to Parramatta, April, 1929, complete service, November, 1929. Granville to Cabramatta, November, 1929, complete service, March, 1930. Strathfield to Hornsby, March, 1930, complete service, November, 1930.

An Automatic Disconnecting Switch

The Alabama Power Co., U.S.A., has developed an automatic disconnecting switch which replaces the ordinary hand operated switches and fuses usually used for sectionalising and protecting branch high voltage overhead lines in districts of low loading density. The switch is of the outdoor type, spring operated, and is tripped on overload by means of a coil and plunger. Such tripping alone, however, is not desirable for there are certain classes of transient overload, such as the flash over of an insulator from temporary causes, which do not require permanent clearing of the line. Mechanism is therefore provided which causes the disconnecter to work in conjunction with the oil switch at the substation controlling the trunk feeder, so that the faulty section will only be cut out when persistent trouble develops. This arrangement consists of an inverse time limit relay which delays the completion of the trip coil circuit for a set period after the overload comes on. The oil switch at the sub. is of the automatic reclosing type. When it is tripped it recloses after a period of one minute. If the trouble persists it trips again and recloses a second time after a period of one minute. If the trouble is still present it opens again and is this time locked out.

By arranging the time delay of the sectionalising switch so that the oil switch will trip first the function of breaking the circuit is removed from the disconnecting switch to the oil switch. This, however, does not clear the trouble for the oil switch closes again in one minute. When this occurs a further overload impulse passes through the relay of the disconnecting switch and, by means of special connections, energises the trip coil and releases the switch. When the substation oil switch closes the second time the overload has been cleared and the trunk feeder therefore remains in circuit. Should the overload be only of a transient nature the substation oil switch will open and then reclose and remain closed. The disconnecting switch relay will commence to function but on the cessation of the overload will stop and reset itself ready for the next operation. After an automatic sectionaliser has opened on trouble it is reclosed by hand after a patrol has been made and the fault cleared.

The Alabama Power Co. has installed these switches on 44,000-volt lines serving country districts. It is stated that this type of switch gives far better service than the ordinary type with fuses. Current for energising the trip coil and driving the small motor which operates the relay is provided by a 12-volt, 80-amp. hour, automobile type battery which only requires recharging once every three or four weeks.

ELECTRIC SUPPLY PUBLICITY

The Manawatu-Oroua power board, which has its headquarters at Palmerston North in the north island of New Zealand, has recently issued an attractive booklet for the purpose of familiarising consumers and the public generally with the nature and advantages of electric supply. The first few pages are devoted to simple definitions and explanations of electrical terms. Following on this are tables showing the amount of power required to drive various farm machines, the energy requirements of the most common household electrical appliances and the work a ha'porth of electricity will do in various directions. Some aspects of the work of an electric supply authority are explained and much useful information given regarding the use of electric motors and other apparatus. The principal aim is to interest farmers and householders in the work the power boards are doing, and impress upon them the advantages of electrification.

HYDROELECTRIC POWER IN SPAIN

Investigations are being made with a view to ascertaining the possibilities for hydroelectric development along some of the principal rivers in Spain. The rivers gather the greater part of their waters on the central plateaux of the country at altitudes ranging between 6,000 and 1,500 ft. In general the waters run in deep-cut channels, thus offering very favorable opportunities for their employment in the generation of electricity. The river Tagus has a flow between 12 and 1,000 cu. metres per sec. at times of drought and flood respectively. The Guadalquivir varies between 10 and 5,000 cu. metres per sec. Thus it will be seen that it is necessary to regulate the flow by artificial means. Works to carry this into effect have already been undertaken to a considerable extent in one section. It is estimated that on the latter stream about 100,000 h.p. can be developed between Cordova and Seville, in addition to making water available for irrigation. On the Douro river, which forms the boundary between Spain and Portugal, it is estimated that 300,000 h.p. can be developed within a length of 60 miles.

There is already a fair amount of hydroelectric power developed throughout the country. The principal enterprise is that of the Barcelona Traction, Light and Power Co., which was established in 1913 and in ten years increased its gross revenue from £40,000 to £706,500. Another development, on the Rio Durcal, has a 3,400 kw. installation supplying power in Granada and Almeria, including a certain amount of electrified railway. With further railway electrification projects in view it is certain that further extensive hydroelectric developments will be taken.

A Super-Tension Power Cable

On a 90-mile line of the Societa Interregionale in Italy, operating at 130,000 volts, 42 cycles, with ungrounded neutral, a section of 2,000 ft. of No. 1/0 single-conductor cable in three lengths (total 6,000 ft. of cable with six splices and six terminals) has been installed by one of the leading cable manufacturers, the Pirelli company. The cable is made up of a certain number of copper wires stranded around an iron-wire spiral which leaves a hollow core. The insulating paper (43/64-in.) is wrapped around the copper wires in the normal way and is covered with lead, after which a protecting layer of paper and tarred jute has been applied. Experiments made in the manufacturer's laboratories as far back as 1911 brought to light the fact that the dielectric strength of impregnated paper is closely related to the resistivity that the paper offers to the passage of a gas, and special resistivity coefficients were determined for the various kinds of paper and insulating compound. The tapering off of the dielectric strength from the inner layer (1,270 volts per mil) to the outer layer (760 volts per mil) was adopted in the cable in question. This gave to the various layers dielectric strength that was more in relation to the dielectric stresses there existing.

Another new feature regarding the manufacture of this cable is that the impregnating of the paper is done after the lead has been applied. The moisture is removed by a current of dry air sent through the hollow core; then the vacuum is applied, after which the fluid compound is allowed to flow in. The hollow-core construction adopted supplies the means for filling up the empty spaces which are formed every time that the cable goes through a certain temperature cycle, maintaining always a perfect impregnation of the dielectric. The hollow-core construction has also simplified somewhat the splice construction (which is made of built-up insulation around a copper sleeve which supplies the continuity of the hollow core and on which the copper wires of the conductor are soldered) as the perfect impregnation that can be obtained by it permits keeping the size of the lead sleeve of a splice down to a diameter slightly larger than the cable.

Special precautions were necessary at the terminals of this cable in order to limit the tangential dielectric stresses at the point where the lead terminates. The potheads also had to be made oil-tight. After the cable was laid in the ground, the splices made (using special precautions to limit the moisture while splicing), and the potheads connected, the vacuum was applied while an electric current was made to

flow through the conductor to facilitate the drying of the cable, following which the cable was filled with compound.

Special oil tanks, placed a few feet above the highest point of the cable and made moisture-tight in a way similar to that adopted for transformers, maintain the cable thoroughly impregnated at all times, allowing the taking up of any expansion or contraction of the cable due to changing temperature. The lead sheaths of each conductor were connected together at each end and solidly grounded.

Factory tests were made on each cable length between conductor and lead as follows: 150,000 volts for fifteen minutes, 175,000 volts for one minute, 200,000 volts for one minute. The cable was laid in November, 1923, with a temperature between 0 deg. and -5 deg. C. The line was placed in service from March 20, 1924, to May 15, 1924, at 65,000 volts, and since October 6, 1924, it has been operating at 130,000 volts with ungrounded neutral.—(Electrical World.)

POWER BOARDS AND ADVERTISING

The question of power boards advertising their wares through the usual mediums was subject to some controversy recently in New Zealand. As a result the Auckland power board decided to break away from the non-advertising principles which had been in operation. It, therefore, launched out on a small advertising campaign for the purpose of increasing the sale of water heaters and electric stoves. With a view to ascertaining the results of this advertising, the campaign was conducted in such a way as to permit of a comparison of sales during advertising and non-advertising periods. It was noticed that as a result of the first newspaper notice, sales of both items increased quite appreciably for a few days and then dropped. The programme was continued, and within a few months a several hundred per cent increase in sales was recorded.

The value of illustrations as an advertising adjunct was exemplified in the case of water heaters, for the additional cost of preparation of advertisement blocks was more than compensated for by the great increase in the sale of heaters. The ratio of sales between stoves and heaters was approximately two to one in favor of the heaters. As the average price per unit for these installations lies round about £30 the value of advertising in these cases will be realised.

As a result of this initial success the Auckland board intends to carry on with advertising in the future. It will use the columns of the daily papers as the chief medium of operations, though other widely circulating journals will not be neglected.

THE QUALIFICATIONS OF A GOOD MANAGER

John T. Broderick, writing in the *General Electric Review*, sums up the essential qualifications of a manager and shows how their value may be assessed in picking a man for an executive position. Most discussions about keeping an organisation well manned cover only a limited field and do not extend to men filling positions beyond the rank of a foreman. But while it is important that foremen be capable, it is even more important in the case of men of higher rank. A misfit in a minor job muddles things at one point, but in a big job he can wreck an enterprise.

The essential qualifications of a manager, rated in order of importance, are as follow:—Intellectual honesty, imagination, judgment, personality, knowledge, experience, energy. By intellectual honesty, the most vital qualification, is meant straight thinking. No one whose mental processes are crooked, however able he may be, can get far in a managerial job. Those under him will take care of that if those above him overlook it. Workers will often do their best for a leader with some of the attributes of a blockhead, if he is square with the light that he has, but withhold loyalty from one who is shifty, even if brilliant; and of course organic efficiency is never possible without a loyal spirit. The next qualification, imagination, so far as it relates to administrative duties in industry, may be defined as the power to understand what is not obvious, to balance and coordinate a great variety of factors, and to see ahead and plan ahead. One of its indications is a readiness to entertain and try new ideas. Judgment may be classed with imagination, but is listed as a distinct basic qualification in order to emphasise the fact that a manager must have decision, and be a doer as well as a seer.

Personality, knowledge and experience need no particular definition, but it may surprise many to see energy listed last. The kind of energy referred to here, however, is the physical or bustling kind which, although excellent in a man in a subordinate position, may be distinctly harmful in an executive. The danger is that a superabundance of energy coupled with little imagination leads to lost motion and duplication of effort and sometimes to serious blunders. In addition the individual labor, so to speak, of the manager cannot be very much greater in volume than that of any one worker, but the volume of his induced labor, or that performed by others under his inspiration, must be very great. Team work being the outstanding requirement in an industrial organisation the individual hustler has a mission only as he works constructively with others and is as eager to promote their efficiency as his own.

It will be noted that executive ability is not classed as a basic qualification. This is so because such ability is a result of coordination of the qualifications mentioned. Treating it as a distinct qualification probably leads to many misfits in management. Executive ability, for example, is popularly associated with energy, and the dangers of an energetic executive have already been discussed. A man who is high in imagination, but low in energy will make the better manager provided he has a fair proportion of the other qualifications, although his nature often leads him to classification as a dreamer.

Now in choosing a manager the qualifications may be each assigned a definite proportionate numerical value. The proportion of each qualification in an individual may be assessed by observation and knowledge of his character. This also may be assigned a numerical value. The total then of the figures resulting from multiplication of the values of each qualification by the factors assigned to their proportions in the individual, will give a figure which will be a basis of comparison with other individuals. Allowance must, of course, be made for differences of opinion as to the relative quantities of each quality in a man's make up and for collateral qualifications such as age, health and temperament. Nevertheless it is definitely possible to assess a man's fitness for a managerial job in a mathematical form, and to predict his performance with reasonable accuracy, due allowance being made for the fact that human beings are not merely mechanisms but are liable to change through outside influences.

NYMBOIDA HYDROELECTRIC SCHEME

The Clarence River county council has adopted the report of Mr. N. V. S. Wilton, engineer and manager of the Nymboida hydroelectric scheme, for the half-year ended June 30, 1925. The progress made has exceeded the most sanguine expectations. The number of consumers connected during the period totalled 885. The total connected load at the end of the period was 1,189 kw., and the peak 325 kw. Units generated reached 389,840, and units sold 264,670. The quota for testing, etc., was 1,800, and transmission and distribution losses amounted to 123,370 units, or a percentage of 31.7. Since the end of June a number of new consumers have been linked up and on July 25 the total was 922. In addition 48 are waiting for connection. The income for the half-year was £4,872, of which £4,423 was from sales. Expenditure on the trading account for the same period was £5,900, of which £2,509 was required for working costs and £3,391 for interest on special loans.

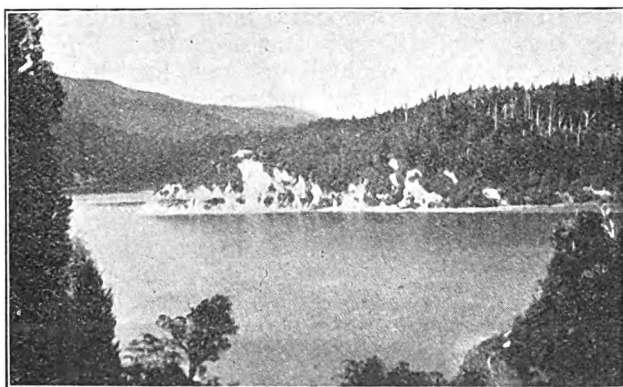
The net loss for the half-year was £1,118, which is well within the original estimate for the early operations of the scheme.

TEKAPO HYDROELECTRIC SCHEME, N.Z.

The South Canterbury power board, New Zealand, has requested the public works department to send officers to confer with members of the board and of the Tekapo league on the question of the future power supplies of the district. At present the board is receiving bulk supply from Lake Coleridge, but it is considered in some quarters that immediate steps should be taken with the development of hydroelectric power from Lake Tekapo in order to supplement this supply. The public works department is preparing a report on the scheme. The estimated available flow from the lake is 5,100 cusecs at a head of 900 ft., which would yield 300,000 kw. at a 50 per cent load factor. Lake Coleridge will probably be loaded up to its full capacity in about five years, and Lake Tekapo should then prove a very valuable source of energy.

THE WAIKAREMOANA POWER DEVELOPMENT

The public works department of New Zealand is taking immediate steps towards the development of a large hydroelectric scheme at Lake Waikaremoana. The scheme has been in the air for some years and was only held up because



Lake Waikaremoana

there appeared no immediate prospect of a demand for large amounts of power which could not be economically supplied from other sources. Now, however, an agreement has been arrived at with the Poverty Bay power board which requires a supply of energy, and the public works department has undertaken to have power available within three years. A small plant of 700 kw. capacity, consisting of the turbine driven exciter sets for the proposed large plant, temporarily coupled to alternators has been installed at Waikaremoana for some time and is leased by the Wairoa power board. The immediate installation contemplated involves a plant of

40,000 h.p. capacity, at an estimated cost of £2,600,000. The site is capable of development up to 130,000 h.p. capacity.

Pending the completion of the hydroelectric plant the Poverty Bay power board intends to take over and operate the 650 kw. steam plant of the Gisborne borough council. The price at which this plant will be taken over is to be assessed by arbitration. The bulk supply from Waikaremoana will be obtained over duplicate transmission lines erected by the public works department.

COLLECTION OF POWER RATES

A number of the local bodies in New Zealand are complaining of the arrangement whereby they are called upon to collect the power rates, not unreasonably contending that the power boards should make their own arrangements in the matter. At a recent conference on the subject attended by representatives of both local bodies and power boards it was generally agreed that the power boards should collect their own rates. This policy, therefore, is now being generally adopted throughout the country.

AFFORESTATION AND THE POLE PROBLEM

In a recent editorial the Electrical Engineer drew attention to the pole problem and briefly mentioned what was being done in the matter. New Zealand is not lagging behind other countries in providing for future power pole requirements, and in some localities extensive afforestation projects are in hand with a view to solving the problem. In Canterbury province especially afforestation is proceeding apace. Progress leagues in the province are alive to the serious situation involving the importation of some £2,000,000 worth of timber into this recently heavily forested country, and considerable areas in the poor land district of Canterbury are gradually being planted with suitable trees.

It is estimated that some 80,000 to 100,000 acres of artificial forests will be required within the next quarter of a century to ensure continuity of power pole supplies. A strong endeavor, therefore, is being made to have areas approaching this estimate planted with suitable types of trees. The government forestry department has already planted some 7,000 acres in the Canterbury district, and has arranged to supply stocks of seedlings to various bodies which are willing to undertake the afforestation of certain waste lands within their immediate jurisdiction.

Canterbury province is not alone in this matter. In the Thames, Waitomo, Golden Bay, Manawatu, and Rangitikei areas definite afforestation schemes are in process of development, and the recognition of afforestation requirements is becoming daily more general.

COMMONWEALTH P.M.G.'s DEPARTMENT

FEW ACCIDENTS WITH ELECTRICITY

Annual Report

The operations of the postmaster general's department for the financial year ended June 30, 1924, resulted in a profit of £364,352. In the telegraph branch a total net loss of £188,982 was recorded, while the telephone branch made a profit of £50,667. The profit on the working of telephone exchanges was £90,257, that on the working of the Sydney-Melbourne trunk line, £15,093; that on the Adelaide-Melbourne trunk line, £6,657; and that on the Sydney-Brisbane trunk line, £4,197. On the other trunk lines a net loss of £80,489 was incurred. On non-exchange lines a total profit of £14,952 was made. The table gives the results of operation of the metropolitan networks only in the various states:

In reply to a recent suggestion that the number of deaths from accidents with electricity was high compared with the number caused by coal gas suffocation, the Victorian electricity commission has issued a statement showing that during the year 1923-24 eight deaths caused by gas suffocation were recorded in Victoria, while only four deaths were caused by electrical accidents. The commission contends that in Great Britain the number of electrical accidents has also been surprisingly small, and in the year 1923 only four fatal accidents were recorded. On the other hand some hundreds of fatal accidents due to gas poisoning were reported.

Network	Number of Subscribers	Operating Expenses	Repairs and Renewals	Revenue	Excess	Net Profit
Sydney	58,019	£116,415	£330,907	£795,596	£348,274	£28,000
Melbourne .. .	45,165	85,764	198,473	621,142	336,905	132,000
Brisbane .. .	12,564	23,483	61,481	182,836	97,872	34,000
Adelaide .. .	15,456	28,154	58,991	262,252	175,107	107,500
Perth .. .	7,597	10,723	43,284	112,140	58,133	19,000
Hobart .. .	2,967	4,025	14,716	35,034	16,293	3,000
						£323,500

During the year many important works were undertaken. A commencement was made with the reconstruction of the Sydney-Melbourne telegraph line and the installation of the carrier wave system; preparations were made for installing telephone repeaters between Sydney and Melbourne; the teletype system of printed telegraphy was introduced on the Melbourne-Bendigo circuit. Several automatic telephone exchanges were installed in the metropolitan areas, and at June 30, 1924, 32 per cent of the city subscribers were receiving automatic service.

MELBOURNE TRAMWAY OPERATION

Increases in the revenue, passenger and mileage figures of the cable and electric services for the year 1924-25 are shown in a recent statement issued by the Melbourne tramways board. The detailed figures as follow:—

Year ended June 30, 1924—			
	Revenue	Passengers	Miles
Cable . . .	£1,184,280	147,800,506	14,716,919
Electric . .	686,279	74,091,564	7,267,966
	£1,870,559	221,892,070	21,984,885
Year ended June 30, 1925—			
	Revenue	Passengers	Miles
Cable . . .	£1,185,444	148,316,398	15,285,913
Electric . .	749,492	80,435,680	8,426,519
	£1,934,936	228,752,078	23,712,432

AUSTRALIAN STANDARDS ASSOCIATION

The Australian Commonwealth Engineering Standards Association has issued a tentative specification and description of tests for Portland cement. It is based upon the British standard specification but includes certain alterations necessary to meet local conditions. Proper methods of sampling are defined and particulars given of the various chemical and physical tests. The testing apparatus is described in detail with the aid of numerous drawings, so that there should be no mistake about obtaining proper conditions for the tests. An appendix outlines the methods of analysis for estimating the proportions of the several constituents of the cement under test.

The Melbourne tramways board has accepted the tender of the Foundation Co. Ltd., of London, for the conversion of the St. Kilda road cable line, and branches, to electric traction. The contract price is £144,800, and the work will take about 12 months to complete. 6.43 miles of double track are to be converted and a new double track .82 mile in length is to be laid. The work is to be carried out in sections, each section being brought into electric operation as completed. During the construction period the passenger traffic will be catered for by motor buses and by electric cars running on temporary tracks.

Radio News

The Queensland state radio station, 4QG, is now in regular operation.

A radio club has been formed at Bendigo, Vic., and a proposal is afoot for the establishment of a broadcasting station in the city.

The American short wave station, KDKA, has been heard fairly consistently lately by Australian amateurs.

A four-valve set and loud speaker were recently installed on a motor bus plying between Adelaide and Glenelg, S.A. The aerial was mounted under the roof and the equipment gave quite satisfactory reception.

One of the short wave experimental transmitters on the U.S.S. Seattle makes use of a crystal oscillator for control of wave length. Such a device is comparatively new to radio work, but it has been found very successful, giving an absolutely constant wave length.

Lieutenant Schnell, the representative of the Radio Relay League with the American fleet, has a high opinion of Australian amateur transmitters. He says that the Australian amateur stations were heard night after night all the way out from America. In some instances the signals were so powerful that they could be heard across the deck.

The fees for broadcast receivers' licences have been reduced by 7/6 all round instead of the 5/- originally contemplated. The new rates, which will come into force on Aug. 1, are as follow:—27/6 for zone one, 25/- for zone two, 22/6 for zone three.

Owing to delays in the manufacture of the 5 kw. transmitting set, Central Broadcasters Ltd., Adelaide, have not been able to complete their new station in the specified period. The controller of wireless, however, has granted an extension of time and it is expected that services will be inaugurated early in September.

The New Zealand government has framed regulations which provide that every vessel, except those trading only in harbors, carrying over 25 persons must be equipped with wireless apparatus. The limit of 25 persons is imposed only because with smaller vessels the expense of radio apparatus and an operator would be proportionately too high to be a commercially reasonable proposition.

There is a movement in the United States towards the establishment of what may be termed super-power broadcasting stations to take the place of many of the small transmitters operating at present. Such stations, by the

strength of their output will largely overcome static interference in receivers within a fairly large radius. Station WJZ, operated by the Radio Corporation of America, has already opened with a moderate output, but plans are in hand for increasing the power up to 40 or 50 kw.

BROADCASTING IN NEW ZEALAND

There has been a great deal of delay in the establishment of an adequate broadcasting service in New Zealand. Nearly 18 months has passed since steps were taken to form a company which would undertake broadcasting throughout the Dominion. The government drew up regulations for the control of these services but they were not acceptable to the company, which has been holding out for a 10-year tenure of rights instead of the five years offered by the government. A new company, however, has now notified the government that it is prepared to take over the whole project of broadcasting according to the rules and conditions laid down, and this offer has been accepted. An agreement has been signed between the government and the promoters of the company, under which 500-watt broadcasting stations will be erected at Auckland, Wellington, Christchurch and Dunedin. Messrs. W. Goodfellow, of Hamilton, and A. R. Harris, of Christchurch, are trustees for the company, and they have undertaken to have the Auckland and Christchurch stations running within six months, and to erect the Wellington and Dunedin stations when requested by the government. The capital of the company is £20,000.

INVESTIGATION OF RADIO PHENOMENA

A report read before the wireless section of the Institution of Electrical Engineers, London, gives an account of the results of certain researches into radio phenomena carried out by the Marconi Wireless Telegraph Co. Ltd. The principal work was carried out by engineers of the company who voyaged around the world making observations of the strength of signals received from various commercial stations. From the results of this unique prolonged test, the validity of the attenuation formulae in general use can be investigated.

A remarkable phenomenon was noted during the voyage. At certain points signals were apparently being received from both directions round the world simultaneously. The effect produced was similar to that given by two c.w. signals of slightly different frequency—low frequency beats. On one occasion the signals were being received from a New York station while the ship was in the Pacific ocean, 12,000 km. away, and at the same time signals were arriving along the long great circle route from

the south-west—a distance of 28,000 km. This produced a blurring effect on signals received by an ordinary frame or vertical aerial, but the effect was not obtained when a unidirectional receiver was used. Another unexpected effect was the superiority of transmission from west to east over that in the opposite direction. Thus communication from America to Great Britain is easier than reversed traffic, although the difference is not very great.

Special attention was paid to the occurrence and character of atmospherics. The usual salvos of “grinders” were received in the tropics, and crashes, clicks, and fizzes are other appropriately-named disturbances which add to the strain on an observer. Atmospherics are always produced over large areas of land in the tropics, and appear to reach a maximum at about three p.m. local time. By means of the directional type of aerial it was possible to determine the general direction from which continuous atmospherics were arriving. This varied with the season. During the homeward voyage the source of the grinders was found to move westward with the sun, and regular observations were made on atmospheric strength and direction simultaneously with those of signal strength. This very comprehensive research, lasting nearly nineteen months, and involving much expert work, has been successful in removing some of the difficulties associated with successful commercial radio communication. Theoretical considerations have been confirmed and new theories advanced.

BINAURAL BROADCASTING

Mr. F. M. Doolittle, writing in the *Electrical World*, describes experiments with a new method of broadcasting which gives remarkable results. With the apparatus in present use although perfect reproduction of speech or music may be obtained, the listener has no conception of space consciousness. An analysis of the function of listening shows that in certain cases this is quite a serious defect. For instance, in listening to music from an orchestra the pleasure is considerably enhanced and the balance of the sound improved by the ability to fix the relative location of the various instruments. The listener to broadcast reception misses this, though perhaps without knowing it, and it is for this reason that he can never be deceived into believing that he is actually at the scene of the original performance, even if the transmission and reception are technically perfect.

The faculty of space consciousness depends upon the simultaneous functioning of both ears, in much the same way that appreciation of distance depends upon the simultaneous functioning of both eyes. Advantage has been taken of this fact in designing the binaural system

of broadcasting which supplies each ear with the slightly different sound picture necessary to fix the location of the origin of the sounds. The difference in the sound pictures is largely a matter of the phase relation of the sounds arriving at the two ears. The effect is obtained by employing duplicate broadcasting and receiving sets working each on a separate wave length. Two microphones are used at the transmitting station and the telephone receiver at the receiving station is arranged with each earpiece connected to a separate receiving circuit.

An experimental station, WPAJ, operating on the binaural principle has been installed at New Haven, U.S.A. Two standard broadcasting microphones are used with a separation of about 7 in. between centres. One of these modulates a 268-metre transmitter and the other a 227-metre transmitter. It has been found possible either to radiate from separate antennae each coupled to a trap circuit tuned to the opposing wave length, or to couple both transmitters to the one antenna. The former method gives somewhat the better results. At the receiving end a single aerial with a duplex receiver embodying two separate tuning and amplification circuits gives good results. It is essential for the best reproduction that headphones be used for reception, for if loud speakers are employed the sound which is intended for one ear reaches both. Reception from the station in the usual way with an ordinary single receiving set is not impaired since the same programme can be heard on both wave lengths.

SELF INDICATING ACCUMULATOR

The Peto and Radford accumulator is adapted principally for radio work and has advantages which should ensure for it a long life even in the hands of persons who know little of battery maintenance. It is made up in the form of a two-volt cell enclosed in a clear celluloid container. Printed instructions for charging and maintenance of acid level are attached to each cell. The cell incorporates a device which renders the state of charge instantly ascertainable without the use of any instruments. It consists of three floats located in vertical chambers at one end of the cell. These are weighted to sink in turn as the specific gravity drops on discharge. The white float sinks at 1,180 sp. gr. or 50 per cent discharge; the blue at 1.165 sp. gr. or 75 per cent; and the red at 1.157 sp. gr. or 95 per cent discharge. Thus the operator knows at all times just what is the state of his cell, and he should be able to keep it in good condition for long periods. The cells are made up in 40, 60, and 80 amp. hour capacities priced respectively at 40/-, 47/6, and 55/-.

New Publications

Power Station Operation., Vol. 1. Electrical Times Ltd., London. Pp. 100. Price in Australia, 4/6.

This small volume is a collection of reprints from the Power Station Operation column of the Electrical Times. The subjects have been classified under convenient headings and the information, written as it is by experts, is of great value. Many interesting points in connection with both the steam and electrical side of power station work are raised and dealt with, and the book should prove a very handy reference work for the operating engineer.

Small Electric Generating Sets. By W. Wilson. Ernest Benn Ltd., London. Pp. 154. Illus. Price in Australia, 22/-.

The use of small generating sets for giving electric supply to houses or small communities in remote localities is growing rapidly, and there is now quite a large variety of apparatus designed to give service in this manner. In general such sets are installed under expert supervision, but their running and maintenance are left in the hands of persons with little or no technical knowledge. The aim of this book appears to be to supply those in charge of small generating sets with that information which is essential to an intelligent performance of the usual operating and maintenance routine. The great proportion of the volume, therefore, is devoted to descriptive matter, with which is coupled a certain amount of elementary theory of the action of the various parts. There are chapters on the secondary battery, the dynamo, the internal combustion engine, non-automatic, semi-automatic and full-automatic sets, and there are numerous illustrations and descriptions of modern types of plant.

Electricity and the Structure of Matter. By L. Southern, M.A., B.Sc. Oxford University Press, London. Pp. 120. Illus. Price in Australia, 3/6.

This small book is one of "a new series of introductory volumes, designed not only to give the student who is undertaking a special study some idea of the landmarks which will guide him, but also to make provision for the great body of general readers who are sufficiently alive to the value of reading to welcome authoritative and scholarly work if it is presented to them in terms of its human interest and in a simple style and moderate compass." In the first section a brief sketch is given of the history of the development of electrical science up to the discovery of the electron. This is by way of introducing the terms and ideas employed in the later sections. The major portion of the book is devoted to descriptions, in simple terms, of several of the principal modern developments and

discoveries in regard to electricity and the structure of matter. In this section there are chapters on radio-activity, atomic architecture, electro-magnetic waves and atomic aggregates. The various subjects are dealt with in an interesting and instructive manner.

Electric Vehicles. By C. W. Marshall. Chapman and Hall Ltd., London. Pp. 94. Illus. Price in Australia, 12/-.

The efficiency of the electric battery vehicle for short-haul service is such that it is coming to be a very solid competitor with other forms of transport. The principal advances in design have been made in America and consequently the influence of American practice is very strong. The author of the present volume deals principally with British practice but the American influence is very marked. The first portion of the book is largely descriptive of various types of battery and vehicle. Later chapters, however, deal with operating experience, working costs and tests and contain some very interesting and useful information. In reviewing the prospects of development in battery vehicle work the author states that the objective to be aimed at is to obtain for electric vehicles practically all the city work done by horses. He also says that for very heavy traction the six-wheel type of electric lorry has good prospects of success in competition with steam and petrol road vehicles. Such opinions indicate that experience gives rise to great faith in the future of the storage battery vehicle. The book is full of information of value to those carrying on road transport operations, particularly in city service.

Illuminating Engineering. By F. E. Cady and H. B. Dates. John Wiley and Sons, Inc., New York. Chapman and Hall Ltd., London. Pp. 469. Illus. Price in Australia, 31/6.

This volume is one of the most complete yet published on the science and art of illumination. It is the outcome of practical experience in teaching a course of illuminating engineering at a technical school and constitutes a compilation of data from many sources. It is divided into two main sections, the one dealing with the principles of illumination, and the other with the applications. The ground is covered very thoroughly. In the first section are chapters devoted to the physics of light production, consideration of sources of light, photometry, physiological optics and fundamental principles of lighting. The second section deals with the various specific applications of illumination and the special problems which arise in practice. Much valuable data is presented, in the form of tables and charts. One very useful chart gives the reflection factors of different colored surfaces. The authorship of the chapters is varied. Each is written by a man well able to speak with authority on his particular branch.

Trade Notes

The Leonard Electric Co. Ltd., of Melbourne, manufacturers of electrical heating appliances, is in voluntary liquidation.

Company Liquidation.—Messrs. Corbett, Derham and Co. Pty. Ltd., manufacturers of and dealers in radio equipment, are in liquidation.

The Towns Lighting Co., with capital of £11,000, has been formed in New South Wales for the purpose of reporting on and installing electric supply schemes.

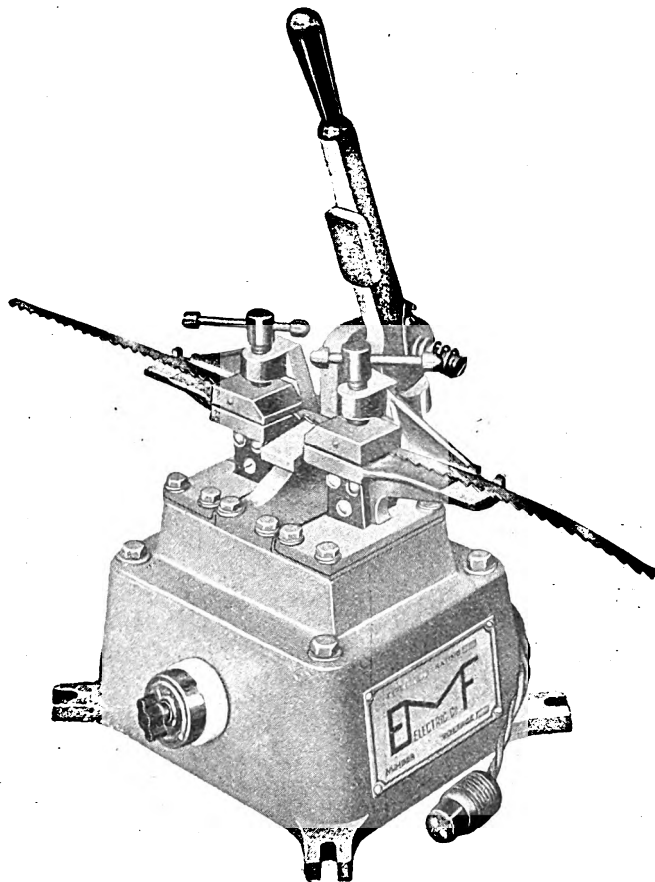
Commonwealth Mica Co., with first place of operations at Cloncurry, Qld., has been registered in New South Wales. The nominal capital is £5,000. Mr. John Stewart, of 163 Clarence street, Sydney, is manager.

The Graham Wireless and Electric Co. Ltd. has been registered with authorised capital of £25,000 to trade as wireless and electrical dealers. The directors are Messrs. A. V. Graham and C. O. Smithers and the office is at 106a King street, Sydney.

Success at Exhibition.—At the recent All-Australian exhibition held in Adelaide, organised by the S.A. chamber of manufactures, Hecla Electrics Ltd., of Melbourne, were successful in winning every possible prize in the electrical section. The prizes included: £25 donated by the Adelaide Electric Supply Co. for the best display of domestic electrical appliances, a silver medal and a certificate of merit for electric radiators, and a silver medal and certificate of merit for electric heating and cooking apparatus.

Johnson and Phillips Ltd.—Speaking at the annual meeting of shareholders in London on May 7, the chairman (Mr. W. Claude Johnson) referred to the fact that the company has attained its jubilee. "You have already learned," he said, "that events seem destined to celebrate this anniversary by making it another record year in the company's history. During those 50 years we have grown from small and modest beginnings in an infant branch of engineering to an important and recognised position in a giant staple industry. Electrical engineering may now, perhaps, be said to be the most important section of the engineering industry; it penetrates and permeates all other sections, and is closely allied with every one of our industries, arts, and sciences as an indispensable servant. We have taken our part in the past in that development, and are ready to take our share in the future, which we believe to hold still more astonishing progress in store for the electrical industry."

Electric Band Saw Brazier.—The E.M.F. Electric Co. Pty. Ltd., of Melbourne and Sydney, has developed a brazier for jointing band saws which should prove invaluable in wood-working shops. It is in effect a small butt welder with provision for applying pressure in a vertical direction instead of along the axis of the parts being welded. It is very simple in operation. The ends of the saw are prepared in the usual way and placed in the self-aligning clamps with the correct overlap. A small strip of the solder is



placed between the surfaces to be joined, the flux applied and the current switched on. As soon as the solder melts the current is turned off and pressure applied by means of the centre clamp. The clamp is then released and the current turned on again just long enough to give the saw the proper temper. The temper is entirely within the control of the operator. If it is too hard, current is turned on until it is drawn. If too soft, cooling can be obtained by application of the centre clamp with the switch turned off. With this machine the braise is effected in a few seconds, the heat is uniform and air is excluded during the cooling, therefore the resultant braise will be faultless. The rating of the machine is such that over 100 braises can be made at a current cost of 2d. The price of the machine is £16/10/-.

Cosmos Lamps.—The Metropolitan-Vickers Electrical Co. Ltd. announces that it has appointed W. G. Watson and Co. Ltd. as exclusive representatives in the Commonwealth for the well-known Cosmos lamps. These lamps enjoy a reputation second to none in the British Isles and abroad and their manufacture embodies the latest methods. Stocks arriving include the following types:—Gas filled, vacuum, carbon, automobile, battery, hand, torch, flash, medical, miners', projector, candle, traction, ship, train, tubular and spot-light, etc., which can be furnished in colors, frosting or special markings. Folders, price lists, window and table showcards and displays of very attractive design, will shortly be available for free distribution to accredited dealers. All Cosmos lamps are guaranteed against defective workmanship and material and each one is subjected to a special test before despatch.

Cables and Wires.—The Enfield Cable Works (Australasia) Ltd., through their head office, Sydney, advise that they have appointed W. G. Watson and Co. Ltd. as agents for Victoria, Tasmania and Newcastle, N.S.W., for wires and cables, manufactured at their works, Brimsdown, England. This company's products carry the hall mark of the British Cable Makers' Association, and include the following ranges:—Paper insulated cables, rubber cables, lead covered and armored cables, bitumen cables, air space telephone cables, trolley wires, aerial cables, trailing cables, cotton and silk covered wires and flexibles, copper wires and strand, plain or tinned hard or soft. Although not long established in Australia some notable contracts have been secured. Amongst the purchasers are numbered: P.M.G.'s department, Melbourne, Melbourne city council, state electricity commission of Victoria, Victorian railways, Victorian state coal mine, public works dept., N.S.W., Sydney city council, N.S.W. government railways, City Electric Light Co., Brisbane, Queensland railways, Western Australian government tender board, Auckland electric power board, Auckland trams, Wellington, Christchurch, Devonport, Invercargill and Dunedin city councils, New Zealand government railways, New Zealand public works dept. Messrs. W. G. Watson and Co. Ltd. will in due course be carrying complete stocks at their several branches.

POSITION VACANT

Applications, closing Sept. 1, are invited for the position of assistant engineer with the City Electric Light Co. Ltd., Brisbane. Experience in the transmission and distribution of electrical energy is essential. The commencing salary is £500 per annum.

ADVERTISING ELECTRICITY

The electric supply department of the Newcastle city council has launched out on an extensive publicity campaign with a view to popularising the use of electricity in the home. An electric shop has just been opened with the objects of providing a display of electrical appliances and educating the public in the convenience and economy resulting from the use of electricity. In this enterprise the council co-operates with the electrical dealers and contractors in the city. Further co-operation is evidenced by the double page of advertisements appearing in a recent issue of a local daily. The central feature of each page is an announcement regarding the council's new show room, while advertisements for various appliances and services by numerous electrical houses and contractors are grouped around.

Additional publicity is obtained through the circulation by the council of a small news sheet which is distributed at the quarterly meter reading. This contains information regarding the operations of the electric supply department and short articles explanatory of the advantages of electric supply. The electrical engineer, Mr. Guy Allbut, is working along sound lines in this publicity and it will be interesting to note the results of the campaign.

A record breaking advertising sign is being installed at the Eiffel tower, Paris. 200,000 lamps are being used to form an automobile advertisement. It is stated that the advertiser pays rent equivalent to £14,000 a year and a municipal tax of £12,000.

The board appointed under the N.S.W. electric lighting and gas emergency act, 1917, has been reconstituted. Members are as follows:—Messrs. J. M. Baddeley, minister for mines and labor, J. C. Alexander, A. Wilson, F. W. Kitching, and C. F. C. Evers.

The Commonwealth postmaster general's department has ordered a further 210 miles of Hume Pipe reinforced concrete conduits. These conduits are used for undergrounding telephone cables, and this order covers extensions of important lines in Victoria, South Australia and Western Australia.

Owing to the excessive traffic a hold-up recently occurred in the Brisbane tramway service. The general manager has stated that the trouble is due to the power distribution system which was originally designed for a much smaller volume of traffic than is now being handled. The trust is installing substations, which will distribute the necessary power for increased traffic.

At the request of the Victorian electricity commission the state government has decided to appoint an engineer to investigate the activities of the commission. The state electricity supply schemes have been subjected to a great deal of criticism and it is desired to clear up the whole matter.

The electric supply committee of the Sydney city council has decided to increase the salary of the city electrical engineer, Mr. H. R. Forbes Mackay, from £2,000 to £3,500 per annum in view of his additional responsibilities in connection with the erection of the new power station.

Lighting and Power

Armidale, N.S.W.—The auditors' report submitted at the annual meeting of the City of Armidale Electric Supply Co. Ltd. disclosed a net profit of £466 as against a loss of £429 in the preceding half-year. The company's assets at April 30, 1925, totalled £36,194, compared with £30,920 at the same date, 1924. The subscribed capital was £21,867. The £12,000 guaranteed overdraft at the bank was drawn on to the extent of £11,360. The chairman in his remarks expressed the opinion that dividends would not be paid for two or three years, but others held a more optimistic view.

Auckland, N.Z.—The public works department is now supplying the Auckland power board with a maximum of 2,000 kw. of energy from Horahora, delivered over a 110,000-volt transmission line from Hamilton to the Penrose substation. To cover the cost of extensions during the next four years it is estimated that loans totalling £900,000 will be required. Loan proposals are in course of preparation and will be placed before the ratepayers at an early date.

Sites have been fixed for substations through which the public works department will supply energy to the Waitemata power board. The county substation will be about three miles north of Henderson. Its capacity will be 1,000 kv.a. and it will take supply at 11,000 volts. The north shore substation will be erected between the boroughs of Takapuna and Northcote, and will have a capacity of 2,000 kv.a. at 11,000 volts. Steps are being taken towards acquiring the electric supply undertaking of the Devonport borough council.

Bagdad, Tas.—A proposition for giving electric supply to the district is under consideration. Energy would be purchased in bulk from the hydroelectric department at Bridgewater, and delivered over an 11,000-volts single phase line through Pontville. Mr. C. B. Davies is the consulting engineer.

Bangalow, N.S.W.—The Byron shire council is calling tenders for the supply of material for the reticulation of the town for electric supply.

Blenheim, N.Z.—A contract has been let for the construction of a diversion tunnel 300 ft. long and 9 ft. 7 in. wide in connection with the Marlborough power board's Waihopia hydroelectric scheme. The board is calling tenders for supply, delivery and erection of two 750-h.p. turbo-generators.

Bombala, N.S.W.—The municipal council has granted a franchise to a private company for the supply of electricity throughout the district. Supply is to be at 400/230 volts, a.c. Mr. R. Houston, of Sydney, is consulting engineer.

Broome, W.A.—A referendum is being held on the proposal to borrow £10,000 for an electric supply scheme.

Casino, N.S.W.—Tenders for the completion of the municipal electricity undertaking will shortly be invited. It is hoped to have current available before the end of the year.

Clare, S.A.—The electric supply from the power station of the Mid-North Electricity Co. has been officially

switched on. The plant consists of two 100-h.p. and one 50-h.p. Fairbanks-Morse crude oil engines driving, respectively, 75-kv.a. and 40-kv.a. alternators. The districts supplied also include Seven Hills, Penwortham, Watervale, Leasingham, Auburn, Rhynie, Undalya, Riverton and Saddleworth. Mr. W. H. Whitney is the electrical engineer.

Cressy, Vic.—A proposal has been made that electric supply be extended to the town from Beeac.

Dandenong, Vic.—Mr. T. Farr has been appointed superintendent of the electricity commission's Dandenong electric supply district. Mr. A. G. Ashley is the officer in charge at Lilydale, which is included in the district.

Eaglehawk, Vic.—The Electric Supply Co. of Victoria Ltd., has offered to supply electrical energy to the borough. It is stated that the present cost of generation in the municipal plant is £1,188 per annum, but that the cost of bulk supply would only be £757 per annum.

Euroa, Vic.—The main engine at the council's power station was damaged recently through the breaking of a bolt in the connecting rod. The general condition of the plant is causing some anxiety and the lighting committee has recommended that the shire council purchase an 83-h.p. crude oil engine to drive the larger generator.

Fairfield, N.S.W.—A loan of £7,500 is being raised for the purpose of electrical extensions.

Frankston, Vic.—The Frankston and Hastings shire council is raising a loan of £5,000 for extensions to the electric supply.

Gisborne, Vic.—The use of batteries in the electric supply station of the shire council has been discontinued. The plant includes two 15-h.p. Fairbanks-Morse type Y crude oil engines, belt driving Westinghouse d.c. generators. Mr. Cole is the engineer in charge.

Greensborough, Vic.—The electricity commission has approved of a scheme for electric supply to the town.

Hamilton, N.Z.—The central power board has been authorised to raise a loan of £12,000 for electric supply purposes.

Helensburgh, N.S.W.—The electric supply was switched on on July 17. The undertaking is in the hands of the Bulli shire council, which purchases bulk energy from the Metropolitan Coal Co. The Waterfall sanatorium is supplied over a transmission line erected by the public works department. The system is 415/240 volts, 50 cycle three phase a.c. There are at present 125 consumers, and the streets are lit by 91 lamps. The reticulation was carried out under the superintendence of Mr. T. Freeman, the shire electrical engineer.

Junee, N.S.W.—The municipal council has decided to reduce the price of electricity by 2d. per unit.

Kandos, N.S.W.—A poll of ratepayers taken relative to a proposal to light the town by electricity has resulted in an affirmative vote.

Laura, S.A.—The municipal council has accepted the offer of Mr. A. H. Forder to renew his contract for

the supply of electrical energy for a period of five years at 1/1 per unit. Continuous service is to be provided.

Lower Hutt, N.Z.—The Hutt Valley power board is raising a loan of £40,000 for electric supply reticulation.

Macksville, N.S.W.—Tenders are shortly to be invited for a franchise covering supply of electricity for the district. Mr. R. Houston, of Sydney, is preparing details.

Mudgee, N.S.W.—The municipal council proposes raising a special loan of £20,000 for the purpose of establishing an electricity supply undertaking. The suggested expenditure is as follows:—250 b.h.p. Diesel engine and alternator, £4,861; two 150-b.h.p. engines also two 125-kv.a. alternators, £6,066; switchboards, meters, etc., £2,117; poles, mains, insulators, £4,810; 76 street lights, £380; land and buildings, £1,260; storage tanks for fuel, £400; contingencies, £106.

Murchison, Vic.—The Waranga shire council is making inquiries with a view to the installation of an electric supply scheme for the town.

Nanango, Qld.—The shire council has received a report on an electric supply scheme for the town. An estimated expenditure of £6,600 will be involved if the scheme is adopted.

North Illawarra, N.S.W.—On July 17, the electricity supply obtained from the Metropolitan Coal Co. was officially switched on. The system is 415/240 volts, 50 cycle, three phase a.c.

Orange, N.S.W.—The municipal council is raising a special loan of £19,000 for additions and extensions to the electric supply undertaking.

Penrith, N.S.W.—Opponents to the proposal of the municipal council to borrow £7,000 for electrical extensions, have appointed Messrs. J. Adams and A. Jones as representatives to interview the minister for local government. A petition opposing the scheme was circulated but did not receive the required quota of signatures.

Peterborough, S.A.—A recent poll of ratepayers on the question of borrowing £4,800 for extensions to the electric supply resulted as follows:—For, 69; against, 19.

Port Moresby, Papua.—Arrangements have been completed for the extension of the street lighting system to the villages of Hanuabada and Elevala.

Pukekohe, N.Z.—The Franklin power board has been granted an order in council authorising it to undertake the supply of electricity and to purchase the undertakings of the borough of Pukekohe and the Franklin Electric Supply and Trading Co. Ltd. The main supply will be taken in bulk from the public works department, and

the suction gas generating stations at present operated by the abovementioned authorities will be used as standbys.

Riverton, S.A.—The electric supply, from the plant of the Mid-North Electricity Co. at Clare, has been switched on.

Rushworth, Vic.—The Waranga shire council recently requested the minister for works to grant special permission for the council to install a refrigerating plant which would operate on surplus energy from the electrical supply undertaking. The electrical engineer, Mr. A. McCaskill, pointed out that a substantial profit could be made from the venture. The permission, however, was refused on the grounds that it was undesirable for the council to undertake a trading enterprise.

Stanhope, Vic.—The progress association has requested the electricity commission to make a survey with a view to bringing electric supply to the town when available.

Takaka, N.Z.—A new electric power district has been proclaimed, and the election of the board, which will be known as the Golden Bay power board, will be proceeded with shortly.

Tamaki West, N.Z.—The power plant of the Tamaki road board is overloaded and arrangements are being made for taking a bulk supply of energy from the public works department's Horahora hydroelectric station.

Tauranga, N.Z.—The first generating set at the borough council's new hydroelectric station at McLaren's Falls is now in commercial operation and is carrying the load satisfactorily.

Unanderra, N.S.W.—The Central Illawarra municipal council proposes raising a special loan of £7,000 for the purpose of carrying out electrical extensions. The approximate disbursement will be as follows:—Poles and cables, £2,343; meters, £1,760; lamps, £300; labor, £1,263; substation equipment, £700; contingencies, £624.

Violet Town, Vic.—Mr. E. E. Fosdick has been appointed engineer-in-charge of the municipal electric supply undertaking.

Waimairi, N.Z.—The county council is borrowing £1,500 for the extension of the electric supply reticulation to Brooklands.

Westport, N.Z.—The borough council is raising a loan of £2,300 for the completion of the electric supply installation.

Yarrowonga, Vic.—The electricity commission took over the control of the electric supply undertaking on Aug. 1.

Current Prices for Electrical Supplies

The quotations in this list represent the average retail selling prices ruling in Melbourne during the month of publication. These prices are subject to bona fide traders' discounts. Special rates are obtainable in most cases for large quantities. In general Sydney prices are slightly lower.

Adaptors—

Hardwood	doz.	11/3
Parallel	each	6/6

Blocks—

3 in. round	gross	22/6
3½ in. round	gross	25/
6 in. x 3 in. rectangular	doz.	6/3
9 in. x 3 in. rectangular	doz.	7/6
6 in. x 6 in. square	doz.	12/6

Bushes—

½ in. ideal metal	gross	7/6
¾ in. ideal metal	gross	7/6
1 in. ideal metal	gross	8/9
1 in. plain wooden	doz.	1/6

Bushes—

1 in. plain wooden	doz.	1/8
1 in. plain wooden	doz.	2/

Bells and Bell Material—

Bell transformers	each	12/6
1½ volt dry cells	each	3/-

Bells and Bell Material—

Bell wire—1/029 d.c.c.	1,000 yd.	32/6
1/036 d.c.c.	1,000 yd.	42/6
1/029 d.c.c. and i.r.	1,000 yd.	50/
1/036 d.c.c. and i.r.	1,000 yd.	60/
No. 2 porous pots	each	2/1
No. 2 jars	doz.	8/9

Bells and Bell Material—

No. 2 zincs	each	1/3
Salammoniac	lb.	1/3
2½ in. wood box bells	each	4/6
2½ in. iron box bells	each	4/6
3 in. wood (church gong)	each	18/4
Bell presses	from each	3/9

Pocket Lamp Batteries—

Batteries, pocket lamp	each	1/10
2-cell batteries	each	2/5
3-cell batteries	each	2/8

Ceiling Roses—

	English	Japan
2-plate	doz. 10/	5/5
3-plate	doz. 13/9	7/11

Connectors—

1-way, porcelain	doz.	2/6
2-way, porcelain	doz.	4/
3-way, porcelain	doz.	5/

Counterweights—

Porcelain	each	2/6
Brass	each	5/6
Shot for same	lb.	6½d.

Casing and Cover—

Best white pine	100 ft.	12/6
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Conduit—

	Plain	Screwed
½ in.	100 ft. 10/	20/
¾ in.	100 ft. 10/10	20/
1 in.	100 ft. 15/	27/6
1 in.	100 ft. 27/6	40/
1½ in.	100 ft. 45/	60/
1½ in.	100 ft. 68/	85/
2 in.	100 ft. —	135/
¾ in. oval	100 ft. 12/6	—

Conduit Fittings—

	½ in.	¾ in.	1 in.
Grip—Tees	doz. 3/6	3/6	4/3
„ Elbows	doz. 2/9	2/9	3/6
„ Couplings	doz. 2/3	2/3	2/9
Crampets	gross 5/5	5/5	6/3

Conduit Fittings—

	gross	5/	5/	5/5
Saddles		½ in. & ¾ in.	¾ in.	
Screwed tees	doz.	5/5	7/6	
„ elbows	doz.	3/9	5/5	
„ couplings	doz.	2/9	4/	
„ bell mouths	doz.	5/	5/	
„ „ „ 1 in.	doz.	14/10		
„ „ „ 1½ in.	doz.	19/6		
„ „ „ 1½ in.	doz.	27/		

Junction Boxes—

	½ in. & ¾ in.	¾ in.
2-way	doz. 10/10	10/10
3-way	doz. 11/3	11/3
4-way	doz. 11/3	11/3

Fuses (Cut-outs)—

	British	Japan
5 amp, anchor type	doz. 10/	5/
5 amp, round chamber	doz. 17/6	8/9
8 amp, round chamber	doz. 20/	12/6
10 amp, oblong	doz. 35/	25/
20 amp, oblong	each —	3/

Holders—

	English	Japan
C/G., S.C. holders	doz. 12/6	8/9
½ in. and ¾ in. holders	doz. 12/6	8/9
Batten holders	doz. 13/9	10/

Lamps—

Metal Filament, Vacuum Type		
25 to 250 volts, 20 to 60 watt	each	2/
20 to 250 volts, 100 watt	each	5/

Lamps—

Gas-filled Type		
20 to 250 volts, 25 to 40 watt	each	2/9
60 watt	each	3/3
75 watt	each	3/9
100 watt	each	5/8
150 watt	each	7/
200 watt	each	9/
300 watt	each	13/
500 watt	each	17/6
750 watt	each	22/6
1000 watt	each	27/6
1500 watt	each	40/

Carbon Filament

All voltages, 5 to 32 candle power	doz.	24/
All voltages, 50 candle power	doz.	42/

Plugs—

5 amp two pin plugs	doz.	30/
5 amp two pin tops	doz.	15/

Shades, Opal—

8 in.	doz.	11/3
9 in.	doz.	17/6
10 in.	doz.	21/3

Switches—

	English
5 amp s.p. pol. brass	doz. 17/6
5 „ s.p. ox. copper	doz. 19/3
5 „ 2-way pol. brass	doz. 30/
5 „ 2-way ox. copper	doz. 33/
10 amp. s.p. pol. brass	doz. 37/6
5 „ d.p. pol. brass	doz. 40/
10 „ d.p. pol. brass	doz. 85/
5 „ s.p. ceiling switches	each 5/6
5 „ 2-way ceiling switches	each 7/6
1 „ ceiling switch and rosette	each 5/6

Switches—

3 „ American tumbler	doz. 24/
3 „ s.p. indicating rotary	doz. 24/
3 „ s.p. non-indicating rotary	doz. 22/6
3 „ 2-way rotary	doz. 56/3
5 „ d.p. indicating rotary	doz. 62/6
10 „ d.p. indicating rotary	doz. 78/
20 „ d.p. indicating rotary	doz. 150/

Switchboards—

	English	Japan
Single circuit marble 5 amp	each 9/9	8/
Single circuit marble 10 amp	each 17/6	16/3
Two circuit marble 5 amp	each 19/2	15/10
Two circuit marble 10 amp	each 25/	22/

Switchboard Frames—

6 in. x 6 in. local make	doz. 9/6
6 in. x 8 in. local make	each 1/
8 in. x 8 in. local make	each 1/3
8 in. x 10 in. local make	each 1/6
10 in. x 10 in. local make	each 1/8

Tape—

Black adhesive	lb. 2/9
Pure rubber	lb. 10/

Wire and Cables—

	Per 1,000 yd.
1/.044, 600 meg.	£5 12 6
1/.064, 600 meg.	£8 12 6
3/.036, 600 meg.	£9 15 0
7/.036, 600 meg.	£17 0 0
7/.044, 600 meg.	£21 10 0
7/.064, 600 meg.	£36 10 0

Flexibles—

	Per 100 yd.
23/36 cotton	£2 2 6
40/36 cotton	£2 12 6
70/36 cotton	£3 10 0
110/36 cotton	£4 5 0

Electrical Contracts

TENDERS OPEN COMMONWEALTH

P.M.G.'s Dept., General.—Sept. 15—Lamps, lamp caps, and lamp sockets, telegraph equipment. Sept. 29—Protective apparatus. Oct. 20—Jumper wire, bells, buzzers, switchboard cable. Oct. 27—Timing clocks and calculagraphs, cordless switchboards, telephone transmitters and associated parts. Nov. 10—Telephone receivers and associated parts. Nov. 17—Junction material, magneto.

P.M.G.'s Dept., N.S.W.—Sept. 24—Excavating machine, Nov. 6—Automatic common battery, telephone equipment, Canberra exchange.

P.M.G.'s Dept., Victoria.—Aug. 25—Pneumatic tubes.

STATES

N.S.W. Public Works Dept.—Aug. 31—Substation transformers, Pt. Kembla electricity supply. Sept. 14—Electrical equipment for Cook's River bridge. Sept. 21—Telephone communication system, Barren Jack hydro-electric development; insulators for 33,000 volts and metering equipment for Kiama-Nowra transmission line; meeting equipment for substations, Barren Jack hydro-electric development.

N.S.W. Railways and Tramways.—Aug. 19—Steelwork for masts and overhead structures. Aug. 26—Two 50 kv.a. transformers; Eighty 55-h.p. traction motors. Sept. 2—Two 250-kv.a. transformers; 25 "P" type tramcars, 50 bogie trucks. Sept. 9—Electric travelling jib crane, three 100-kv.a. single phase transformers. Sept. 23—Four feed-water meters. Oct. 7—20,000 kw. turbo-alternator, 15 small single phase transformers. Oct. 21—Two-ton industrial electric elevator; five-ton electric overhead travelling crane. Nov. 11—Five-ton, three-motor, electric overhead travelling crane. Dec. 16—Ten 1,800-kv.a. single phase transformers.

State Electricity Commission of Vic.—Aug. 24—Motor-driven centrifugal pump. Sept. 14—3,000 kv.a. transformers and spares, armor clad switchgear. Sept. 21—250 kv.a. transformers. Nov. 9—6,600 volt and L.T. lead covered and armored cable; 22,000 volt, 3 core lead covered and pilot cable.

Victorian State Coal Mine.—Aug. 24—Bitumen insulated cable.

Victorian Railways.—Aug. 26—Tramway rails and fishplates; lead covered dry core telephone cable. Sept. 2—Electric motors, gas filled electric lamps for train lighting. Sept. 16—Three phase a.c. induction motor. Oct. 7—Electric cables, two electric transporters; accumulator cells and accessories; train lighting equipment. Oct. 14—Line relays. Oct. 21—Electric cables.

Victorian State Rivers and Water Supply Commission.—Sept. 16—Generator voltage regulator for two 445-kv.a. alternators.

GENERAL

Brunswick City Council.—Aug. 17—Supply and laying 950 yd. H.T. 3-core lead covered underground cable.

Caledonian Collieries Ltd., N.S.W.—Sept. 22—Ward Leonard electric winding engine with switchgear, etc.

Melbourne City Council.—Aug. 21—Gas-filled and metal filament lamps. Aug. 24—Soot blower equipments. Nov. 9—5,000 kw. turbo-alternator.

Melbourne and Metropolitan Tramways Board.—Aug. 25—Storage battery plates. Sept. 29—Steel poles.

Newcastle City Council, N.S.W.—Oct. 15—2,000 kw. or 1,500 kw. turbo-alternator and condensing plant.

Northcote City Council, Vic.—Aug. 18—16,000-kv.a. 3 phase transformers. Aug. 28—Switchboards, switchgear, voltage regulator.

Sutherland Shire Council, N.S.W.—Sept. 1—Insulators, bare copper cables, transformers, meters, switchgear, lightning arresters, street light fittings.

[Complete list of tenders invited and accepted appear in "Tenders." A weekly publication, issued from the office of this journal.]

COMMONWEALTH PUBLIC SERVICE

It is hereby notified that Competitive Examinations for appointment as Junior Mechanic, Telephone Installation and Maintenance; Mechanic, Telephone Installation and Maintenance; Mechanic, Telegraph Workshops; and Mechanic, Light and Power Section, Postmaster-General's Department, will be held on the 31st OCTOBER and subsequent dates.

The Examination for Junior Mechanic will take place in all States, that for Mechanic, Telephone Installation and Maintenance in all States except Tasmania, that for Mechanic, Telegraph Workshop and Light and Power Section in Victoria, Queensland and Western Australia.

The persons who will be eligible to compete at the Examinations are as follows:—

Junior Mechanic.—Males (a) not less than 16 and under 23 years on 7/11/25;

(b) Returned Soldiers under 51 years of age on the same date.

Mechanic, Telephone Installation and Maintenance and Telegraph Workshop.—Males of not less than 21 and under 51 years of age on 31/10/25.

Mechanic, Light and Power Section.—Returned Soldiers under 51 years of age on 31/10/25.

In the making of appointments to the Telephone Installation and Maintenance Section and the Telegraph Workshop, preference will be given to returned soldiers.

Full particulars may be obtained upon written or personal request from the Commonwealth Public Service Inspectors in the capital cities of the States of Examination or from the Secretary, Commonwealth Public Service Board, Melbourne, with whom applications must be lodged on or before the 19th September, 1925.

C. B. B. WHITE, Chairman,
Commonwealth Public Service Board of Commissioners.

THE METROPOLITAN WATER SUPPLY AND SEWERAGE BOARD, BRISBANE

Applications are invited from competent persons for the following positions:—

ENGINEER IN CHARGE

LINESMAN

ASSISTANT ENGINEER

FITTER

SHIFT ELECTRICIANS

FOR ELECTRICAL PLANT, SEWERAGE PUMPING STATIONS AND WORKS—PINKENBA AND LUGGAGE POINT.

The successful Applicant for the position of **ENGINEER IN CHARGE** will be responsible directly to the Board for the operation of the plant and staff under his control, and must have had sufficient technical training and working knowledge to control and operate 11,000 Volt Transmission, High Tension Switchgear, Transformers, Turbo Blowers, Centrifugal Pumps, Multi-cylinder Vertical Gas Engines and Alternators.

SALARY for the above position will commence at £500 per annum.

The successful Applicant for the position of **ASSISTANT ENGINEER** will be responsible to the Engineer in Charge for the efficient operation of all running plant, and the staff employed, and must have had actual experience with High Tension Switchgear, Transformers, Turbo-Blowers, Motor Driven Centrifugal Pumps, Multi-cylinder Vertical Gas Engines and Alternators.

SALARY for the above position will commence at £350 per annum.

Applicants for the position of **SHIFT ELECTRICIAN** must hold the Certificate of Competency issued by the Electrical Workers' Board under "The Electric Light and Power Act, 1896," and must be experienced in operating High Tension Switchgear, Transformers, Turbo-Blowers, Motor Driven Centrifugal Pumps and Alternators.

SALARY will be at Award rates.

Applicants for the position of **LINESMAN** must hold the Certificate of Competency issued by the Electrical Workers' Board under "The Electric Light and Power Act, 1896," and also Linesman's Certificate. The successful applicant will be required to maintain the 11,000 Volt Transmission Line and also the Board's Telephone Lines between Breakfast Creek and Luggage Point sub-stations, and in addition take a shift as Electrician, if so instructed.

SALARY at Award Rates according to Duties.

Applicants for the position of **FITTER** must be capable of carrying out any maintenance work on Centrifugal Pumps and Gas Engine Plant and other plant as required.

SALARY at Award Rates.

Applications for the above positions must state age, whether married or single, and be accompanied by copies only of testimonials, and are to be forwarded to the undersigned not later than 12 noon, 31st August, 1925.

Applications from Members of the existing Staff will be dealt with on their merits.

Canvassing by intending applicants of any Member of the Board directly or indirectly will be considered a disqualification.

Envelopes containing applications must be endorsed outside stating the position applied for.

GEO. JOHNSTON, Secretary.

Office of the Board, Albert Street, Brisbane, 10th August, 1925.





Editorial





ENGINEERING EDUCATION

Opinions in regard to educational systems and practices are poles apart. Methods naturally change with the times and so, too, do subjects. The modern world demands that science be given a prominent place and therefore the classics, which sufficed for 50 years ago, are gradually giving ground, not because they are undesirable, but because time is insufficient and the average mental capacity not able fully to absorb both branches. Thus the purely cultural is giving way to that which has more practical application. In specialised education, or training for professions, this tendency has, of course, attained its maximum development. So wide are the ramifications of even a single science that strict specialisation in a particular branch is usually necessary in order that the student may obtain a thorough grasp of the matter in the relatively limited time before he has to commence earning his living. But in this specialisation lies danger: first, that the classical side of education will be entirely squeezed out in the case of certain professions, with a consequent narrowing of vision and stunting of cultural refinements; and second, that what may be termed the ultra-practical aspect of the training will be overlooked. By the latter phrase is meant a knowledge of ordinary business system and practice, which is essential to smooth and efficient working in various dealings and transactions. It is not proposed to deal here with the first aspect, which may safely be left in the hands of educationalists, but to point out what seems to be lacking in the present specialised training methods in the second regard, particularly with respect to engineering. The deficiency covers points that the educationalist, from his very position, is liable to overlook, but which the practical business man knows are essential.

The average technical school and university giving training in any branch of engineering takes students who have had a good general education up to a certain standard, and gives them a course of specialised theory and practice in their particular intended profession. This course usually covers a good theoretical grounding and an elementary but sufficient knowledge of technical practice, such as machine shop work, etc., in the case of mechanical and electrical engineers. In addition the universities often demand that the students shall spend portion of their vacation in a practical engineering establishment or office, and the technical schools

demand twelve months' practical experience before granting a diploma. A course of this nature, however, misses many points of business practice of which the student will later regret the lack. The insistence upon outside practice for students aims in the right direction but makes the mistake of inferring that during that practice the student will pick up useful business knowledge. This may sometimes apply when he is fortunate enough to link up with a concern which works on a sound system, or where there is someone who will trouble to acquaint the young engineer with the elements of such items as estimating and costing, a smattering of book-keeping and commercial law. But more often than not the student is looked upon as somewhat of an encumbrance because of his lack of knowledge of these subjects, and, because the office is too busy to teach him, he is kept on purely technical work and thus does not get the knowledge he is supposed to be acquiring. No blame is attachable to the office in this matter; the average practising engineer has more to do than be school master to his employees, except in the ordinary course of the day's work, and he is naturally inclined to be impatient with the ignorance of his juniors in certain directions and to take the least troublesome line in dealing with them. Neither is the student to blame for his lack of knowledge. His time has been too fully occupied with his studies to allow him to trouble about what he probably looks upon as extraneous subjects. The sum total of the position is that the young engineer starts in his profession with a good theoretical technical grounding, but little chance of acquiring business knowledge. He will certainly pick up points as he goes along in his career, but in most cases will continue to operate under a handicap that unfits him for executive position. Is not this the reason why it has almost become proverbial that an engineer is not a good business man?

Where is the remedy? Few men have the time, money or talent to follow up a strenuous engineering course with an equally difficult accounting training which will give them a basis to work on. The colleges and universities undoubtedly feel that they are doing their best, and it is unquestionable that the engineering courses are as full and as long as they can conveniently be made. The solution appears to lie in the institution of short, evening post-graduate courses, with lectures on engineering business practice given by practising engineering executives. Competent men, willing to devote some of their spare time to giving instruction

along these lines could doubtless be readily found. The course need not be long. Twelve or even six months, with one or two nights a week would probably suffice. The value to the students and to employers of engineers would undoubtedly more than compensate for the time given. The students would obtain a groundwork on which to build future success, and the employers would reap advantage from the more rapid acquisition by their juniors of the knowledge which will make them more extensively serviceable.

The necessity for a course of business training has already been recognised by many of the technical colleges in the United States. These include in their final year of engineering study a short course in the elements and essentials of commercial law. It appears more desirable in Australia where courses are usually short, not to overload the student in his final year though the evening course suggested obviously does not attain the end in the most efficient manner from the employers' point of view. The latter plan, however, is suggested as the most readily workable. In designing any course of training, however, it must be remembered that, as in all education, anything approaching "spoiling" must be avoided. The student must learn to stand on his own resources, perhaps more in business training than in any other. A thorough grounding in the elements of engineering office practice and the principles of works administration, therefore, is all that is necessary. There are already many text books dealing with such subjects as book-keeping, commercial law, costing, etc., and the aim of the "experience" course should be to bring such books under the notice of the student and encourage him to go deeper into the various matters for himself. Experience is undoubtedly the best teacher, but without a guide as to how to profit by it the lessons may never be properly learnt.

TRAMWAY FINANCES

The chairman of the Melbourne Tramways board has recently made a few preliminary statements with a view to preparing the public for a shock when the next annual report is issued. The plain truth is that the tramways are not paying. The reasons to which this state of affairs is ascribed are: (1) The board is burdened with heavy obligatory payments of amounts which should be met by the consolidated revenue of the state, (2) wages of employees and operating costs generally are on the up grade, (3) competition from other transportation services is keen. The board is certainly entitled to a good deal of sympathy in its endeavors to make ends meet particularly on account of its enforced contributions to funds entirely unconnected with its operations. Were

it read as history that tramway takings were used to help pay the upkeep of the metropolitan fire brigade and the infectious diseases hospital, and to augment a fund for compensating de-licensed publicans, a smile would be raised at the whimsicality of such Gilbertian finance. But the realisation that this is actual fact takes all the humor out of it. Last year from a revenue of £1,947,000 the board paid £106,000 to these funds. It has protested on several occasions and asked that the handicap be removed, but the government evidently finds the arrangement convenient, and consequently takes no action. The effect of the impost is to make fares higher than they need be. There is, of course, no question but that the hospital, fire brigade and licenses fund must be maintained by public contributions, but it is absurd and unjust to penalise the tram travelling section of the public while the competing train and bus travellers do not contribute. In any case, why should the travelling public only have to pay?

The second reason for the increase in operating expenses is a common complaint. Wages have risen and risen again, and costs of materials have naturally followed the wages. Here again the tramway board is entitled to sympathy. Fares, however, have been raised and the board is making strong efforts to increase the efficiency of its system in order to meet the increased costs.

It is the third reason for the adverse balance, however, that is giving the tramway board most concern, viz., competition from other services. Competition from the railways hardly need enter into the question. Melbourne has a sufficient population to warrant both rail and tram services, and to allow both full scope. What competition there is is just sufficient to keep both parties alive to the necessity for maintaining efficient services. The main trouble, however, lies in the motor bus competition, and in dealing with this the board must walk very warily. There has already been somewhat of a storm over the question, and regulations have been drawn up which should have put the competition on a fair basis. But the tramways are still losing business and the chairman of the board says he sees no alternative but to raise the fares in order to make ends meet. This is a very dangerous doctrine. It will be conceded that a wages increase may sometimes necessitate a rise in fares, but a diminution of revenue cannot be dealt with in this way. No merchant ever succeeded in business by raising prices when trade fell off; it is against every principle of economics. When competition is keen the public must be attracted by every possible means. A rise in fares will drive patronage to the competing services. A rise of such a rise is the best news that proprietors have heard for a long time.

The tramways board is blessed with a technical staff that knows how to give good service and is making every endeavor to do so, but the administration that would raise fares in face of competition is obviously unsatisfactory. The duty of the board when revenue is falling off is to increase its efforts to provide efficient and attractive service. If anything fares should be reduced. What is wrong with a publicity campaign? The tram ride is a commodity, and the best advertising methods should be employed to increase sales of that commodity. The tramway system serves certain public parks and picnic resorts. The board is ready to carry people there if they want to go, but there has been very little, if any, effort made to put the desire to visit these resorts into the minds of the people. Then there are round trips for sight-seers. The general public and particularly visitors to the city ought to be informed about these trips, but it is safe to assert that not one person in 1,000 if asked off-hand could tell the routes or the days or times the trips run. Why not run a special tram outing every day in the week? The board has now a golden opportunity of proving its oft-repeated statement that the trams can give better service at less cost than the buses. The technical staff will attend to the maintenance of service, but there must be a backing of administrative wisdom if the efforts are to bear full fruit. Tramways are not a back number, as some people seem to imagine, but they surely will be if those controlling them persist in the antiquated ideas that the trams are entitled to a monopoly of transport, and that a rise in prices is the best means of increasing revenue. What the board needs most is public sympathy. Many of its actions tend to alienate sympathy. Talk of monopolies offends against every popular notion of freedom and fair play, while the raising of fares is the most obvious means of earning disapprobation.

Notes and Personals

Sir Adam Beck, chairman of the hydroelectric power commission of Ontario, Canada, died recently at the age of 68.

The Sydney city council has floated a loan of £800,000 for 15 years at $5\frac{1}{4}$ per cent for use by the electric supply department.

Mr. Ross Duggan, of the Westinghouse Union Battery Co., Swissvale, Pa., U.S.A., arrived in Sydney by the Aorangi on August 21.

Mr. A. A. Burch, managing director of Auto-dial Phones Ltd., Sydney, returned by the Aorangi on August 18 from a four-months' business trip to New Zealand and America.

Mr. P. J. Pringle, engineer and manager of the Electric Supply Co. of Victoria Ltd., has returned to Ballarat from a tour abroad.

A linesman in the employ of the Electric Supply Co. of Victoria at Bendigo was electrocuted recently by coming into contact with a 400-volt main while working at the top of a pole.

During the last two and a half years the Brisbane tramway trust has constructed 25 miles of tracks, taking into account new extensions, duplications and track relaying. Over two-thirds of this is practically unproductive, but it was necessary to the proper working of the system.

Mr. W. Carrick Wedderspoon, managing director of Carrick Wedderspoon Ltd., electrical engineers and merchants, Christchurch, was a passenger by the Orama on her outward voyage to London.

A tablet has been erected at Menlo Park, New Jersey, U.S.A., on the spot where Edison had his workshops from 1876 to 1882. An inscription on the tablet fittingly commemorates the pioneering work of the great inventor.

Mr. W. A. Fardom, formerly Sydney manager of the India Rubber G.P. and T. Co., has been appointed Sydney manager for W. T. Henley's Telegraph Works Co. Ltd., in succession to Mr. J. B. Rumford who recently resigned.

Mr. H. W. Boltworth, director of the Lancashire Dynamo and Motor Co. Ltd., and the Crypto Electrical Co. Ltd., of London, is at present visiting Australia. He leaves Sydney on September 28 by the Euripides for South Africa.

The Western Australian government is asking the Perth city council to release it from its agreement to supply energy in bulk from the East Perth power station until 1962 at $\frac{1}{4}$ d. per unit. Owing to circumstances beyond the control of the authorities the generating costs at East Perth have risen above the price the council is paying.

The Melbourne tramways board reports that the revenue per bus mile on the Elsternwick motor bus route, which was put into operation in January last, is approximately $1\frac{1}{5}$. The running costs, however, are admitted to be in excess of this. The buses on this route have covered a total mileage of 287,683 and have carried 1,418,456 passengers.

Mr. E. P. Bennett, formerly associated with Cargills Ltd., London, is returning to Australia in the interests of a number of well-known British firms. He is due to arrive in Perth on September 24 and will reach the eastern states a month later. He intends visiting New Zealand in December and will return to Sydney for an extended stay in February next. Any communication Mr. Bennett sent to the care of this journal will be forwarded.

Mr. J. H. Hornibrook has been appointed assistant to Mr. R. Silcock, electrical inspector, fire and marine underwriters' association, Queensland.

The Greater Brisbane council, which will take control of affairs as from October 1, has power to absorb the tramway trust. There is also a possibility that it may purchase the undertaking of the City Electric Light Co. There is, therefore, little probability that the tramway trust will proceed with the erection of a new power station.

Mr. J. H. Hindman, manager of the metropolitan electricity board, Brisbane, has been appointed officer-in-charge of the electricity department of the Greater Brisbane council. Mr. Hindman arrived in Queensland from England in 1911 and was first connected with Messrs. Trackson Bros. He subsequently occupied positions with Messrs. Finney Isles, the Toowoomba Electric Light Co., and the City Electric Light Co., and became manager of the Balmoral electricity scheme from which the metropolitan electricity board developed.

Mr. J. M. Crawford, chief electrical engineer of the postmaster-general's department, is a native of Liverpool, England, in which city he obtained his education and first engineering experience. He joined the engineering branch of the British post office in 1896, and in 1901 was transferred to London to assist in the subscribers' telephone work of the post office, which at this time entered into serious competition with the National Telephone Co. For six years he was stationed in the West End, and not only installed the telephone in the royal palaces, but was engineer of communications at the coronation of King Edward.

Later he served as telephone engineer in that most important of London telephone areas, the city itself. In 1912 he was appointed as assistant engineer-in-chief to the postmaster-general's department of the Commonwealth, serving subsequently as state engineer for Victoria, and later as state engineer for New South Wales. He has occupied his present position as chief electrical engineer for the past 18 months, during which time the expansion of the telegraph and telephone services has been very rapid. Mr. Crawford is a member of the Institution of Electrical Engineers and an Associate Member of the Institution of Engineers, Australia.



Mr. H. R. Forbes Mackay, chief engineer and general manager of the electricity supply department, Sydney city council, is due to leave for England on October 7, in order to consult tenderers in connection with the new Bunnerong power station. Mr. S. Y. Maling will assume control during his absence.

The present government of New South Wales has decided to give its support to the Jackadgery hydroelectric scheme for developing power from the Nymboida river, provided the Federal and Imperial governments assist in the matter. The secretary of the Jackadgery committee has received advice from the federal treasurer that arrangements had been made with Mr. Adamson, who is reporting for Armstrong, Whitworth and Co. Ltd., on the Tasmanian paper proposition, to inspect Jackadgery and the Upper Clarence. Arrangements are also being made for the testing at Canadian paper mills of Clarence river timbers for the manufacture of paper pulp.

NEW TARIFFS ON ELECTRICAL GOODS

An extensive schedule of tariff amendments was introduced recently in the federal parliament. Reductions have been made in certain lines but the general tendency is to increase upon existing duties. A list of the electrical items in the new schedule is as follows:—

Item	Brit. Pref.	Intermed.	Gen.
Switches, fuses, lightning arresters; regulating, starting and controlling apparatus; switchboards (ad val.)	35 %	45 %	50 %
Dynamo electric machines, and rectifiers, up to 75 kw. (ad val.)	45 "	55 "	60 "
Ditto, over 75 kw. (ad val.)	40 "	50 "	55 "
Static transformers and induction coils (ad val.)	35 "	45 "	50 "
Electric fans (ad val.)	27½ "	35 "	40 "
Vacuum cleaners	Free	Free	Free
Filament lamps (per lb.)		2/-	2/-
Wireless receiving sets (ad val.)	35 %	50 %	55 %
Arc lamps, covered cable and wire, electric vacuum tubes, measuring and recording instruments (ad val.)	Free	5 "	15 "
Wireless valves (ad val.)		5 "	15 "
Ditto, after Jan. 1, 1926 (ad val.)	27½ %	35 "	40 "
A.c. recording watt-hour meters (each)	10/-	12/6	15/-
or ad. val., whichever rate returns higher duty	35 %	40 %	45 %

ELECTRICAL WORKERS' BOARD, QUEENSLAND

Meetings of the board were held on July 28 and August 4. In the recent examinations for certificates of competency eight candidates passed for the fitter's certificate, 23 for mechanic, 13 for linesman and one for joiner.

The Liquid Rheostat—I.

By W. Wilson, M.Sc., B.E., M.I.E.E.*

The liquid rheostat is, as its name implies, a variable resistance in which the resistant material consists of a liquid, instead of a solid such as the wire spirals and iron grids that figure in the more usual form of regulating and controlling apparatus. It is essentially composed of two metallic electrodes separated by the liquid. These components may be situated within a metallic vessel, the inner surface of which actually forms one of the electrodes; or the current may be led in and out by means of

Since both the solid and liquid forms are frequently available for carrying out the same function, it will be of advantage to consider in some detail the characteristics of the former as compared with the latter.

(1) The liquid rheostat is adapted for conducting safely and reliably the largest currents. The various designs of solid resistor, connected

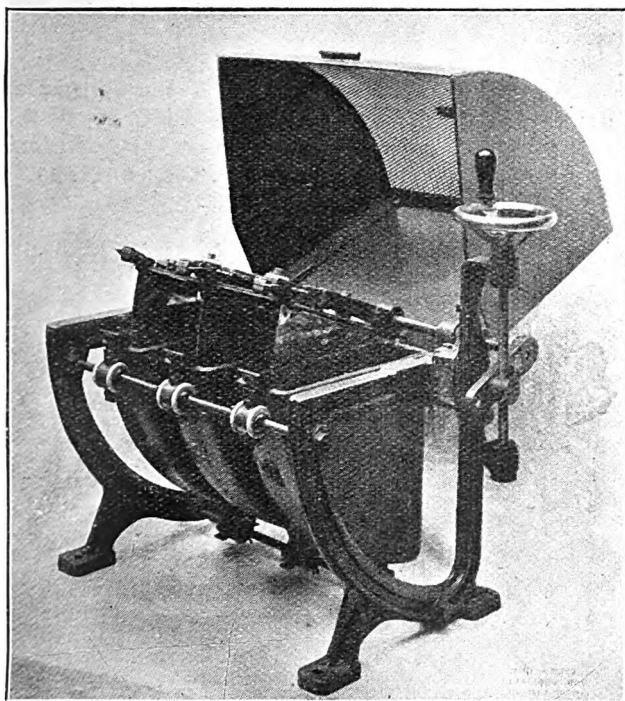


Fig. 1. Three-Tank Liquid Starter, showing Perforated Cover and Short Circuiting Contacts, by General Electric Co., England.

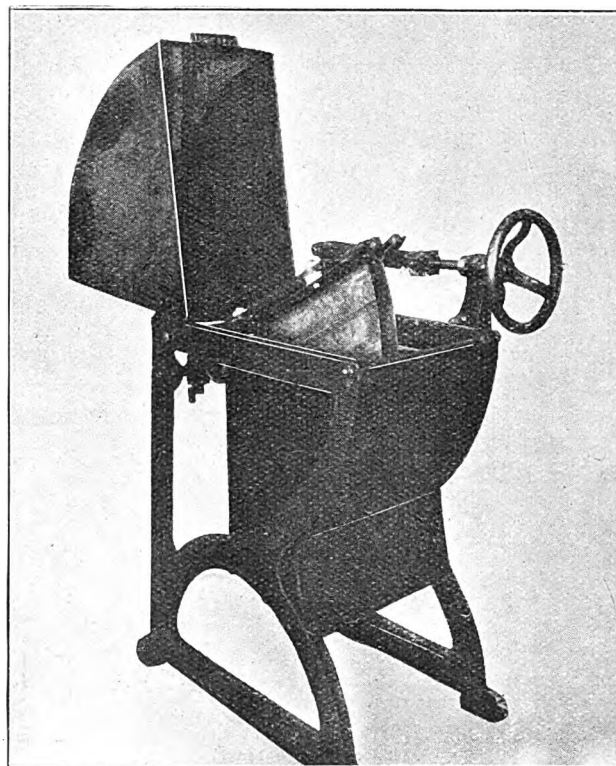


Fig. 2. Single-Tank Three Phase Rheostat with Insulated Dippers, by General Electric Co., England.

two or more quite distinct plates, the containing vessel simply functioning as such, and being composed of metal or of a non-conductor according to convenience.

Such a piece of apparatus possesses two outstanding advantages. In the first place it is easily made up of cheap material; and in the second place it is able to carry the large currents without risk of a serious breakdown. From these characteristics are derived its two principal uses: (a) As a temporary apparatus either for motor starting or control, or for absorbing large quantities of power during initial test runs, and on similar occasions; (b) As a regular and permanent starter or controller for large motors.

*General Electric Co., Witton, England.

and disconnected from the circuit by means of sliding contacts, operate at a greater and greater disadvantage as the magnitude of the current increases. The use of contactors improves the situation somewhat, but adds additional expense, which also increases rapidly with increase of current. It will be found, if the various difficulties in the design of large solid resistors be considered, that these are of small moment when a liquid resistor is substituted. The latter possesses a large storage capacity as compared with a coil or grid, and it is cheaply cooled, when the units are large enough to justify this, by means of water circulation. The piping, pump and other items involved in the cooling are unimportant for large powers.

(2) The liquid resistance possesses a maximum of reliability, since it is practically impossible to break it down. When a solid rheostat is sufficiently overstressed through the specified conditions being exceeded, it comes seriously to grief through overheating, even if it is of perfect design and construction. A single transgression of the limit of safety is capable of throwing the apparatus out of commission until the damaged part has been made good. In the case of the liquid rheostat, however, the result of misuse is simply that the liquid is made to boil, and in nearly every case nothing further occurs. It is certainly the case that the failures to which this apparatus is liable occur during

will by varying its strength, and the absence of steps which require to have a definite relation to one another, permit of great latitude in the proportioning of the various parts. There is no part of the apparatus which is subject to deterioration, and thus the principal difficulties of solid rheostat design and construction are absent.

Against the above must be set a certain number of drawbacks. The most important of these is the variability of the resistance, which may become changed by evaporation, by rise of temperature, by alteration of the chemical concerned, by impurity, or by spilling. Again, the portability is inferior to that of, at any rate, the smaller patterns of solid rheostat, in that the liquid form does not admit of such easy mounting, or of the same treatment in connection with a moving apparatus. Another disadvantage is that the natural cooling of a hot liquid is considerably less effective than that of a set of spirals or grids, since not only is the temperature much lower, but the amount of surface is also considerably less. This is apt to render

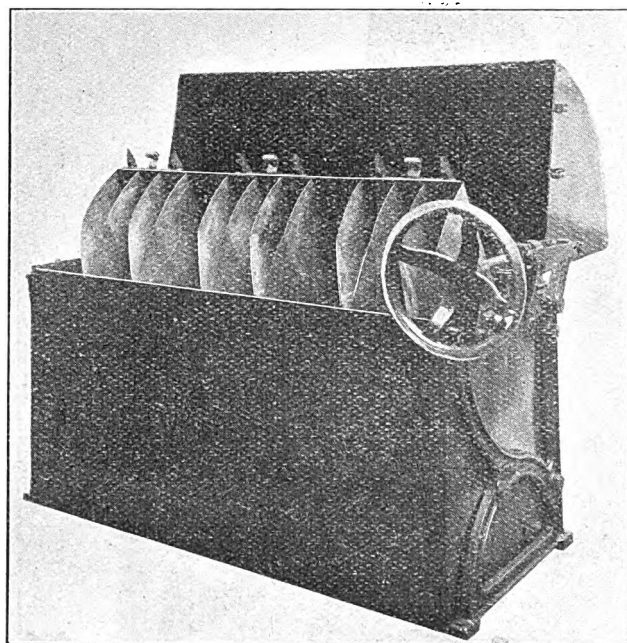


Fig. 3. Six-Tank Liquid Starter, showing Double Dippers, by General Electric Co., England.

ebullition, but they are extremely rare. Ordinarily, when the overload has been removed, the apparatus returns to its former condition and requires no attention to refit it for further service.

(3) The acceleration is smooth, and does not require a multiplicity of steps in order to avoid current peaks. The insertion of the electrodes into the electrolyte being a gradual process, the acceleration or retardation produced in the motor is also gradual. Thus not only are current and voltage peaks obviated, but the maximum safe rate of acceleration is obtained, and thus time can be saved without detriment to the motor.

(4) The apparatus is simple to design and construct. A liquid rheostat is inherently robust, consisting chiefly of sheet steel plates with a minimum of insulation. The ability to alter the specific resistance of the resistant material at

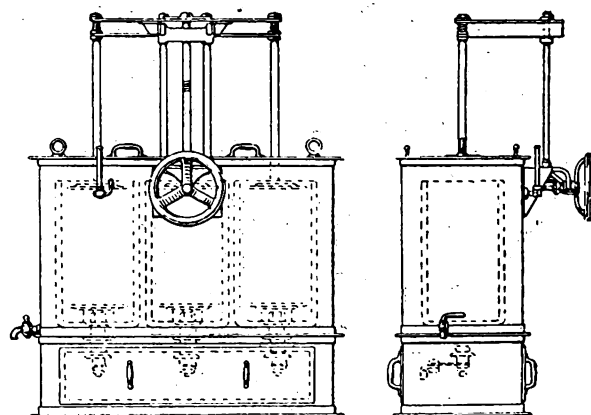


Fig. 4. Liquid Rheostat for Starting Duty with Meters up to 2,000 h.p., by General Electric Co., England. Earthenware Pots shown dotted.

the liquid apparatus somewhat bulky for small powers where cooling by circulating pipes is not a paying proposition. A further drawback lies in the difficulty of cutting the resistance out completely. With many patterns it is customary to fit short-circuiting contacts which come into operation when the electrodes are in their all-in position.

These defects, however, are not of a serious nature, and are only sufficient to turn the scale definitely against liquid rheostats for the smaller sizes. It is nevertheless advisable to keep them in mind when evolving a design.

One of the principal sources of variability of electrolyte resistance is chemical action, which is able to alter the composition of the electrolyte, to erode the plates, and to cause the evolution of gas. It should be recognised, however, that this only occurs to an appreciable degree with

direct current, since with alternating current the chemical actions are reversible, and what takes place in one half cycle is undone immediately afterwards. This chemical effect has discouraged the use of liquid rheostats for controlling direct currents, and the large majority of units are employed in connection with the control of a.c. equipment.

Types of Liquid Rheostat

In common with other patterns of rheostats, the liquid forms may be broadly divided into starters and regulators. In the present case, these are chiefly distinguished by being cooled

tub until the desired results are given. Another method is to employ an iron vessel forming one electrode, the other consisting of a rectangular plate which is lowered into the liquid by means of a simple winch mechanism. When very high potentials are to be dealt with, iron pipes immersed in plain water are used.

Dipper Type.—The simplest form of regular apparatus is that in which a sheet steel electrode is pivoted so that it may be either completely above the surface of the liquid, or gradually immersed in it; the tank containing

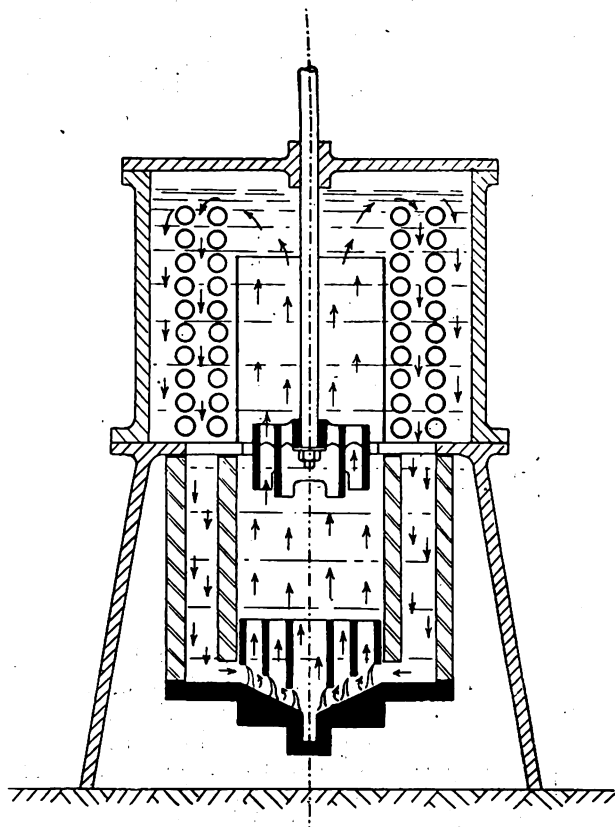


Fig. 5. One Phase of Triple Pot Rheostat, by Messrs. Allen West, showing Perforated Electrodes, Bottomless Pot and Cooling Pipes.

naturally or artificially in the two cases respectively. Practically all the different types that will be described below can be used for either purpose, a starter being converted to a controller by the addition of water circulation. The descriptions cover the principal varieties of liquid rheostat in use.

Temporary Rheostat.—For temporary purposes, a rough liquid rheostat may be composed of a tub, either of wood or earthenware, containing two sheet iron plates mounted on wood cross bearers, or in some other convenient way. A solution of washing soda is employed as the electrolyte, the soda being mixed with a small quantity of water to form a strong solution, and being added gradually to the water in the

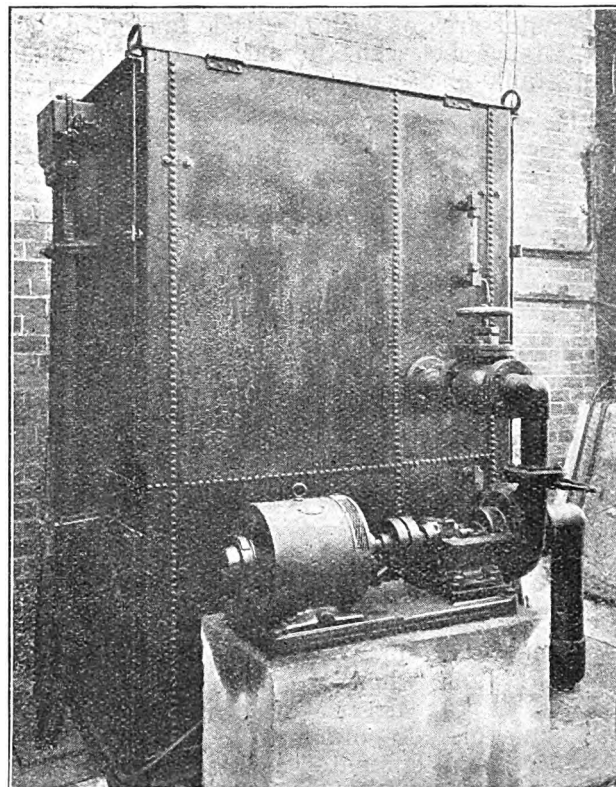


Fig. 6. Rising Liquid Starter for 3,000 h.p. Induction Motor, by General Electric Co., England.

the electrolyte forming the other electrode. This pattern is made in the single phase or single pole form, when it consists of a single tank and dipper; but it may be made two phase or two pole by the duplication of these elements. For three phase working, three tanks and dippers may be used, or a single tank in conjunction with two insulated dippers. Representative designs of these two forms are shown in Figs. 1 and 2. The former pattern may be employed as a "straight through" rheostat by insulating the dippers from one another. Such a rheostat is employed, for example, in the leads of a phase advancer for starting purposes. Since most three phase rheostats are used for gradually short-circuiting the rotor windings of an

induction motor, the dippers are, in general, connected together.

This type is employed for motors up to about 600 h.p. At the upper end of the scale, it is the custom to use more than a single tank per phase. A six-tank pattern, Fig. 3, is rated at 600 h.p. and possesses two elements in parallel for each phase. For the smaller types, a single dipper is used per tank, but the larger have two, which are comparatively wide apart along their upper edges, but approach each other towards the lower extremities. The result is that as they are moved downwards, not only is a greater area of each electrode immersed, but the distance between the latter and the sides of the tank is decreased.

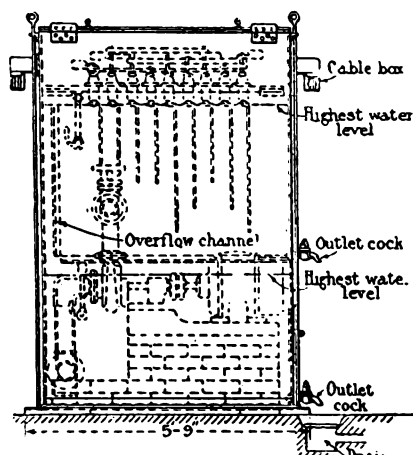


Fig. 7. Rising Liquid Rheostat for 3,000 h.p. motor, by General Electric Co., England.

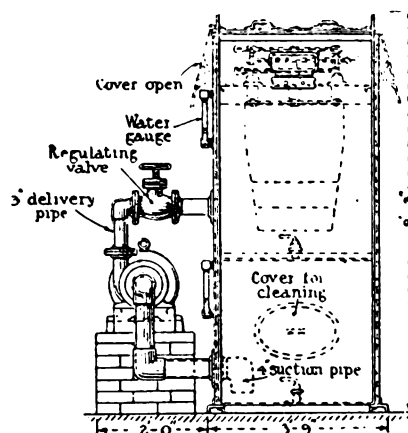
It is not good practice to make the dippers touch the tank when they are in their final position, as the degree of contact would be very doubtful. In order to cut out all the resistance, small laminated contacts are attached to the moving elements, which meet copper or brass flat contacts fixed to the tank. A cover is usually supplied for this form of apparatus to protect it against the intrusion of debris. Ventilation is provided for by the use of perforated metal for at any rate the curved portion; but even this can be made solid if the situation is exposed to dust-laden atmosphere. The dipper type of rheostat does not lend itself very well to artificial cooling and it is therefore generally used for starting service only.

Triple Pot Type.—For motors exceeding about 500 h.p. and up to about 2,000 h.p., the type shown in Fig. 4 is most used. This possesses a single tank, containing three pots, usually of vitrified earthenware, separating the phases. A flat pattern of fixed contact is located at the bottom of each of these pots and a corresponding moving electrode is provided for each, these being connected to a cross beam which can be

raised or lowered by means of the hand-wheel and worm gear illustrated.

The principal defect of this form arises from the risk of breakage of the pots upon exposure to extremes of temperature. There is no doubt that total immersion in the liquid minimises this risk, and the pattern shown should therefore be definitely better than the form in which the pots are exposed to the atmosphere on the outside. To guard against the risk of fracture in the latter, treated wood or enamelled steel are sometimes used.

A further defect is that the circulation is not very thorough, as there are usually no orifices at the lower ends of the pots. There is, however, no strong reason why these should not be provided, as such a rheostat is not required



to have infinite resistance in the full open position, being merely intended to start or regulate an induction motor by varying the resistance of the rotor circuit from a definite fairly high value down to that of the rotor only. A design where provision is made for a through current of liquid is shown in Fig. 5. Since it is not a requirement that the phases should be electrically separate, care should be taken not to make the pots exceed their function as insulators.

This form of rheostat can be employed as a controller by the addition of circulating pipes either round the pots or above them. It is the usual pattern for employing as a liquid slip regulator. In such service the moving electrode is supported by means of the lightest possible links to light arms attached to the shaft of a torque motor. The same rheostat is made to do duty as a starter when beginning work by the provision of a hand-wheel similar to that shown in Fig. 4.

Rising Liquid Type.—The largest motors, up to and exceeding 3,000 h.p. are started and controlled by means of what is known as the rising liquid type of rheostat, an example of which is

shown in Figs. 6 and 7. In this the electrodes are fixed, and the level of the liquid is raised by a centrifugal pump, thus gradually immersing the plates. When used as a starter, the apparatus is operated by means of a single lever which has

capacity of the pump. Upon full speed being reached, the handle is thrown to the final or running position, when the electrodes are short-circuited by an oil-immersed drum pattern switch, and the pump motor is stopped, the electrolyte being thereby permitted to drain away from the upper tank. An interlock is usually provided to prevent the handle being moved on to the final position until the main motor has attained a given speed.

When employed for continuous working, this last form of rheostat is artificially cooled by means of circulating pipes fitted in the lower reservoir. For frequent service the weir type, shown in Fig. 8, is that usually adopted. In this the level of the liquid in the upper tank is regulated by means of an adjustable gate forming practically the whole of one side. This gate is directly operated by the controlling handle, which does not now have to deal with the pumping motor, the latter being kept constantly running. To accelerate the main motor to any given speed, it is therefore only necessary to raise the weir to the position corresponding with that speed, whereupon the pump will fill the rheostat tank up to that level, speeding up the motor at a fixed safe rate. This last type of liquid controller is much used for mine and furnace hoists, and for the control of the largest motors, requiring rapid as well as frequent operation. In some cases these motors require to be fully accelerated in ten or even seven seconds.

(To be concluded)

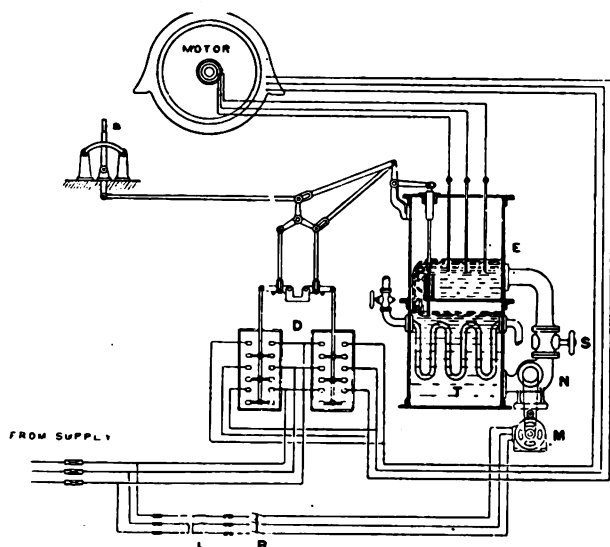


Fig. 8. Weir Pattern of Liquid Rheostat, connected for Reversing Control of a Mine Hoist, by Metropolitan-Vickers Electrical Co.

three positions, one of which is "off." At "start," the pump motor is set in motion, and the pump gradually fills the rheostat tank with electrolyte from the lower chamber. Thus the main motor is gradually accelerated, the apparatus having an inherent time element fixed by the

High Voltage Circuit Breaker Tests*

The American Gas and Electric Co., U.S.A., recently carried out a series of interrupting capacity tests on a 150-kv. three phase oil circuit breaker of a type recently developed by Messrs. Brown, Boveri and Co., of Switzerland. The breaker was set up to short circuit to ground the whole capacity of an interconnected power system with generators totalling 226,200 kv.a. normal rating. The first tests were taken with only part of this rating connected and the breaker dealt successfully with loads up to 330,000 kv.a. On a cycle of eight shots rupturing this load at intervals of 10 seconds the breaker showed little sign of distress and on examination was found in thoroughly serviceable condition.

Further tests were made with the full system capacity behind the breaker, when 725,000 kv.a.

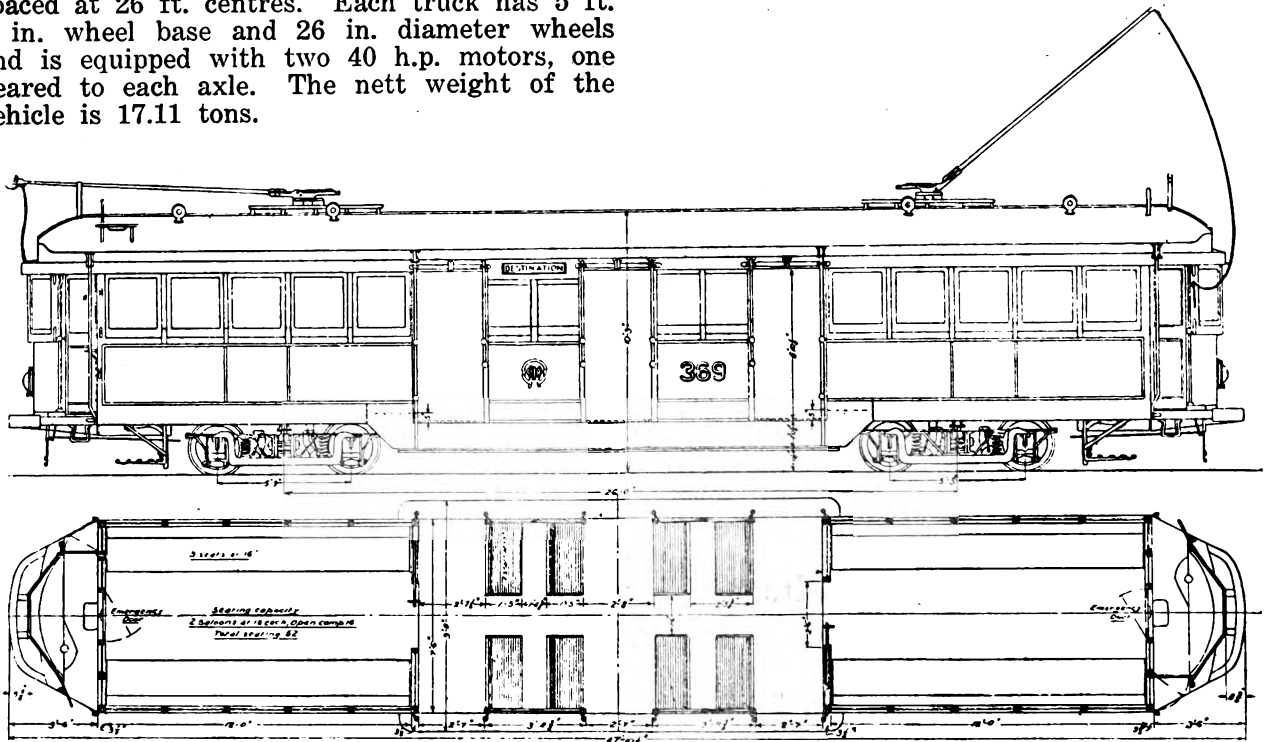
was successfully ruptured. Under this condition the tanks showed some movement and emitted a little smoke, one pole showing more than the others and throwing an appreciable quantity of oil. Examination showed this to be due to charring of one of the barriers between breaks. This particular barrier was a replacement obtained locally which was evidently more subject to burning than the manufacturer's own material. A final cycle of seven shots rupturing 675,000 kv.a. at intervals of one minute was then made. All the shots were cleared with no evidence of distress except the emission of a small amount of smoke and slight spray of oil, and a small movement of the tanks. At the end of the series the burning of contacts was not considered sufficiently heavy to affect the condition of the breaker for closing and carrying its rated current, and the oil, although discolored, tested at about 25 kv.

*The Electrical World.

Standard Car for Melbourne Tramways

As a result of operating experience the Melbourne and metropolitan tramways board has decided that the most suitable car for general service under local conditions is the drop centre bogie car designed by the board's staff, known as the class W. This type, therefore, has been practically adopted as the board's standard. The car has an overall length of 47 ft. 10 in., height from rail to roof of 10 ft. 3 in., width of 9 ft., and seating accommodation for 52 passengers. It is mounted on two equal traction trucks spaced at 26 ft. centres. Each truck has 5 ft. 3 in. wheel base and 26 in. diameter wheels and is equipped with two 40 h.p. motors, one geared to each axle. The nett weight of the vehicle is 17.11 tons.

be obtained through doors leading through the motorman's compartments. The ample passage ways in this car give it a considerable crush loading capacity. The long wheel base and equal tractive effort on all axles make for very comfortable riding qualities. The tramways board is now building a large number of these cars in order to cope with the requirements of several recently opened lines, to provide for the constantly increasing traffic and to replace obsolete



Class W Bogie Car for Melbourne Tramways

Several of these cars are now in service and they have proved satisfactory in every respect. A feature of design which commends them to the operating staff is the placing together of the three entrance and exit passages at the centre of the car. This simplifies supervision of loading and unloading and in practice has been found to considerably reduce the number of accidents through persons boarding or leaving moving cars. The number of accidents arising from the foolhardiness of passengers in this respect has never been enough to warrant the use of interlocking doors on two-man cars, but the centre entrance arrangement appears to practically eliminate the necessity for doors. In case of emergency, exit from the saloons may

and worn out cars. The electric services at present operated by the board cover about 90 route miles or 160 single track miles of lines. With new construction and conversion from cable to electric traction at present in hand a further 27 single track miles will be added within the next twelve months.

The Melbourne city council has made arrangements to supply the Victorian electricity commission with the electrical energy required in the city area by the Melbourne harbor trust. The agreement is for a period of five years and the cost to the trust 1½d. per unit.

Power Supply in Sweden

By R. G. Crivelli, M.E.E. (Melb.)

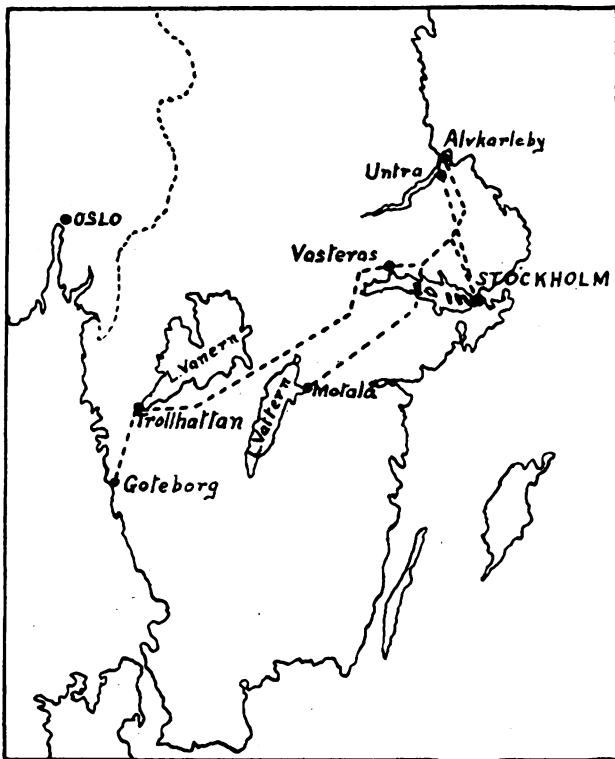
At the end of 1924 modern hydroelectric power stations in Sweden had a total turbine capacity of 1,020,000 kw., showing an increase of 20,000 kw. during the year. In addition, works in course of construction included about 40,000 kw. in private plant and about an equal amount in plant belonging to the state. The consumption of electricity is extremely high, totalling 3,200 million kw. h. per annum. The city of Stockholm alone absorbed 136 million kw. h. during 1924. Approximately 80 per cent of the energy produced is consumed by paper and pulp mills and

lines are so constructed that the pressure can be increased to 220,000 volts if required. Lines of 70,000 and 40,000 volts have also been built. For these voltages single phase transformer units are used, connected in star or delta as required, thus minimising the number of spare transformers connected. A frequency of 50 cycles was adopted, this frequency being predominant in most parts of Sweden. Notable exceptions are the Trollhattan plant, the greater part of which is equipped for 25 cycles and the Untra plant which supplies Stockholm. However, since the greater part of the distribution in the latter city is d.c., there should be no difficulty in supplying some or all of the demand from the 50-cycle system.

At the present time transmission networks supplying large and small quantities of power envelop cities, villages and rural districts. The distribution of electricity on farms has developed to a very great extent. Good illumination is prevalent and electricity is largely used for domestic heating. In planning the networks the possibility of the interchange of power between stations has been kept in view, and several of the larger power stations are at present interconnected. The system of interconnection has some interesting features.

The Trollhattan power station, which was completed in 1910, takes its power from Lake Vanern, a natural reservoir having an immense storage capacity which is not yet used to full advantage. Some idea of this capacity can be formed from the knowledge that by allowing one centimetre difference of water level, approximately 5 million kw. h. can be generated or stored. The Gota river discharges from Lake Vanern. After complete development it will be capable of producing 300,000 kw. or 1,300 million kw. h. per annum. The present capacity of the station is 115,000 kw. There are eleven units, each consisting of a turbine directly coupled to a 25-cycle generator. Two units have a 25 and a 50-cycle generator coupled to the same turbine shaft, so that these machines can feed energy into either the 25-cycle or 50-cycle system or both, as required. In addition, one generator can be used as a synchronous motor aiding the turbine, the machine working as a generator at a slight overload with almost unity power factor.

A transmission line connects Trollhattan to Vasteras where a steam generating station has been constructed. This is used as a peak and reserve power station and as a regulating station, the maximum output being 40,000 kw. The plant includes two 14,000-kw. Ljungstrom turbo alternators which are also used as synchronous condensers. Peat is burned regularly under some



Southern Portion of Sweden, showing Transmission Lines

the iron and steel industry. Electrification of some of the leading railway lines has been completed. Others are approaching completion and will tend to increase the consumption of electrical power and reduce the amount of coal imported. The system adopted comprises a 15,000-volt trolley wire supplying 15-cycle single phase power which is transformed on the locomotive to 200 volts.

The board of waterfalls, which superintends the management of waterfalls, power plants, etc., has planned a network of extra high tension trunk transmission lines, a portion of which has been constructed and put into use. Standardisation of voltage was considered for these lines and a pressure of 130,000 volts adopted. The

of the boilers. A machine shop adjoins the power house and provides the employees with work during the idle periods of the intermittently operating steam plant.

Vasteras is connected to the Alvkarleby power station by means of a 70,000-volt transmission line. The latter station derives its power from the river Dalälven, on the east coast of Sweden. The capacity of the plant is 50,000 kw. The distribution network in the Alvkarleby region interconnects about 100 power consumers all with generating stations of their own, run by water power, coal, oil, or gas from blast furnaces. So far the paralleling of all these stations has not caused any difficulties and a rational distribution of load has easily been maintained.

The Vasteras-Alvkarleby system is itself linked up by means of a 70,000-volt line to the network surrounding the Motala power house which is situated on Lake Vättern. This station has been built to utilise the fall between Lake Vättern and the adjoining Lake Boren. When completed it will include five 6,000-h.p. turbines. One generating set is being provided with a turbine so designed that if spun backwards it will operate as a high efficiency turbine pump,

whilst still having a reasonably good efficiency if used as a prime mover. This set will be run as a pump at night time and on Sundays, using surplus energy from the Alvkarleby system. In this way the energy may be stored in the form of water at a high level, to be again transformed into electrical energy when required. The turbine pump set is only to be used as a generator during brief periods on peak load, and it was designed rather for a high pump efficiency than for a high turbine efficiency. Since the flow of water in the various systems is governed by different conditions, there is little danger of a simultaneous shortage of water in all stations.

The power factor of the network as a whole is about 70 per cent. There is a tendency for shortage of power to be felt in the Alvkarleby region. Therefore the Alvkarleby station is being run at 90 per cent power factor, the wattless current, amounting to approximately 25,000 kv.a., being supplied by Trollhattan or Vasteras. The transmission system is capable of further development and interconnection with other existing systems, and it constitutes the first step in the construction of an immense national transmission network.

Automatic Converter Station for Hobart Tramways

Members of the Tasmania division of the Institution of Engineers, Australia, at the invitation of the mayor of Hobart, recently inspected the new automatic substation installed by the municipal tramways department at the Moonah car shed. The purpose of the station is to step down and convert the high tension a.c. energy supplied by the hydroelectric department to a d.c. voltage suitable for the tramway operation. The equipment comprises a three phase transformer stepping down from 11,000 volts, a 300 kw. rotary converter supplying d.c. energy at 550 volts, a full automatic switchgear installation and a panel for two 400 amp. feeders with contactors and notching relays. The transformer was manufactured by Messrs. Johnson and Phillips Ltd., but the whole of the remainder of the equipment was built by the British Thomson Houston Co., England.

The station starts up either by load demand as indicated by drop in trolley voltage, or by remote control. When in full automatic operation it also shuts down when the load falls off. Starting is effected by means of a relay which causes a small motor to rotate a tramway type controller. This in turn causes the h.t. oil switch on the incoming line to close, with the

result that power is impressed on the converter starting motor and the converter is brought up to speed. When it reaches full speed the converter is automatically synchronised and put on the a.c. line, after which the starting motor is disconnected and the switches on the d.c. side closed by means of solenoids. Automatic protection is provided against overheating of the windings or bearings, overspeed or overload. Should an overload occur due to trouble on the tramway system the d.c. circuit breaker will open and after a short time close again. If the fault is still present it will re-open, and this cycle will be repeated a pre-arranged number of times until, in the event of the trouble not clearing, the converter will be automatically shut down.

This plant will greatly assist the tramways department in maintaining faster services on certain sections of its system during busy periods. It will also provide power for extensions to the system when conditions warrant. The working of the plant was explained and demonstrated to the visiting party by Mr. S. H. Hancox, manager of the tramways department of the Hobart city council.

Power Distribution for Electric Railway*

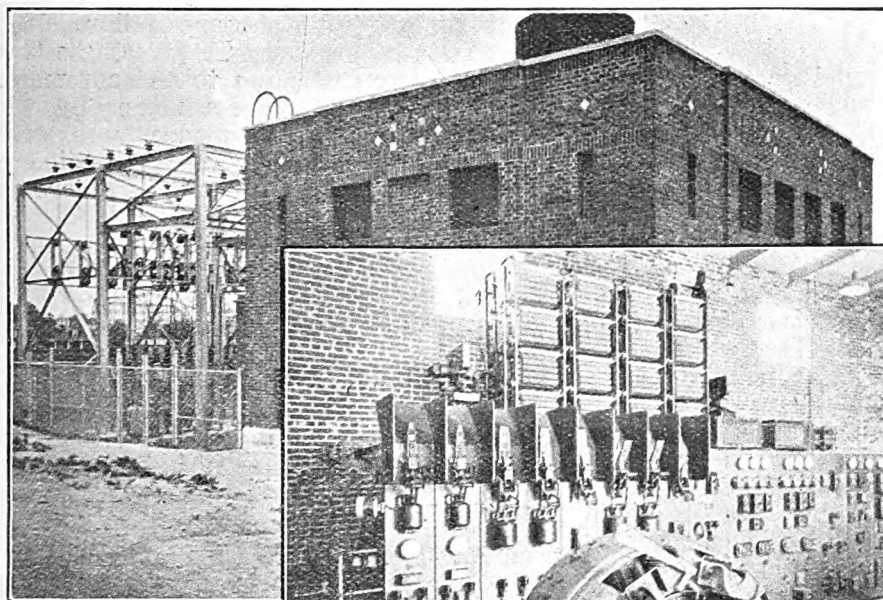
Automatic Substations and Supervisory Control for Staten Island Electrification, New York, U.S.A.

The Staten Island Rapid Transit Railway Co. operates lines on Staten Island in the borough of Richmond, New York city, U.S.A. An electrification project, involving about 18 route miles where there is very heavy traffic, has recently been carried out by the company. The system is 600 volts d.c., with an over-running third rail, and multiple unit trains are operated. Energy

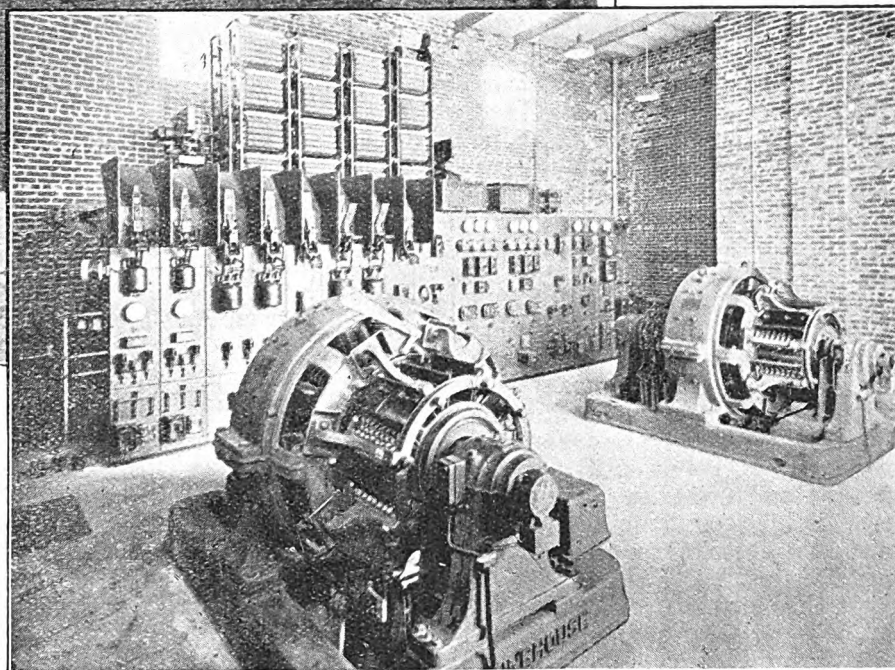
automatic control equipment. The whole of the substation equipment was supplied by the Westinghouse Electric and Manufacturing Co.

Selection of Substation Locations and Capacities

In order to determine the proper locations of the substations and the capacity of each, train sheets were prepared, showing graphically the operation of all trains according to the present and estimated future schedules. Based on the number of units per train, weight per unit, schedule speeds, etc., the momentary energy required for starting and the energy required at



Exterior and Interior of Automatic Traction Substation, Staten Island Rapid Transit Railway Co., U.S.A.



is purchased at 33,000 volts 60 cycle three phase, and supplied to the trains from five substations with an aggregate capacity of 10,000 kw. The principal substation, located at St. George, contains three 1,000 kw. synchronous converters. Three other subs. contain two 1,000 kw. machines each, while the fifth station has only one machine. The four smaller substations are all equipped for full automatic and supervisory control. The St. George station, however, which is the controlling point of the system, has semi-

free running of the trains, composed of from four to six units was calculated. Following this, detail loads were calculated for each mile of track for each minute during the peak load or period of heaviest traffic. From this, detailed load curves of each mile of track were plotted. Since the capacity of each substation must be based on maximum power requirements, only the period of maximum demand was in this manner analysed.

An economic study was made to determine the load losses in the distribution system, based on a number of different substation spacings, and the arrangement best suited to the present and

*Extract from article by C. A. Butcher, Westinghouse Electric and Mfg. Co., U.S.A.

future developments was determined. In order to check the calculations made to determine average voltage conditions incident to normal and peak load conditions, and to check the distribution of load to the substations, the complete system was set up on a mimic network in which proportional loads, voltages and resistance values were used. From this setup, it was also determined that the 1,000 kw., shunt-wound synchronous converter was best suited for the application.

In supplying power to the mimic network at those points representing the substation locations, the inherent voltage drooping characteristic of the shunt-wound converter, supplied from power transformers having eight per cent inherent impedance, was simulated by a series resistor. Under various schemes of loading, based on locations of trains at different times during the peak load, and average load conditions, the voltage at trains and the substation loads were determined. It was also found that the operation of the system is protected against the failure of any converting unit in any of the five substations. A test showed that a concentrated load equivalent to 300 per cent rating of the units in operation in either of two of the substations, when placed at a point directly in front of the substation, would receive 80 per cent of its energy from that substation and 20 per cent from the adjacent stations, dividing 10 per cent to the station on each side. This shifting of load is effected by the drooping voltage characteristic of the equipment only. Similar tests showed conditions of operation incident to various assumed combinations of substations and train operations.

The installation at each of the automatic substations comprises an outdoor structure, which accommodates two power transformers, signal transformer and switching equipment, the high tension switching equipment, lightning arresters and outdoor metering equipment, also a brick building, housing two 1,000-kw., 60 cycle, shunt-wound synchronous converters together with the automatic switching equipment. The starting switches are direct current solenoid operated. Energy for the operation of the substation and supervisory control equipment is provided by a storage battery. A system of relays starts and stops the converters in accordance with the demand for energy for train operation, and the substations are entirely unattended except for periodical inspection visits.

The Supervisory Control System

Experience in the operation of hundreds of automatically controlled substations has demonstrated very well their superiority of performance over manually operated equipment, both from the standpoints of continuity of service and required maintenance and of operating costs. However, automatic equipment set to perform a definite

cycle of operations under given conditions cannot exercise judgment as to when it may be desirable to alter its performance. For example, in contemplating an unusual demand for power, it may be advantageous to have all of the converting units in a substation in operation in advance of such time as they would be brought into service automatically. Also, perhaps, due to an accident to a train which would make it necessary to discharge passengers at some point other than at a station platform, it would be desirable to deenergise the third rail as a matter of safety. Again, information as to the status of the power system must be had at all times if unnecessary failure of power supply is to be avoided. To give these "human" powers of communication to the automatic substations, and to provide a means by which a person intelligently informed may exercise his best judgment as to the best operation of the apparatus, a supervisory control system has been installed.

From a central point located in the traffic operator's office at the St. George substation, four wires constituting two pairs of a telephone cable, radiate to each of the four automatic substations. This cable is paper-insulated for 1,500 volts between conductors and, as a whole, for 3,500 volts to ground, thus rendering it safe from breakdown due to induced voltages from the high-voltage circuits which it parallels along the railroad right-of-way between substations. Great care has been exercised to prevent the grounding of any of the circuits, including those in the same cable, which are used for telephone and telegraph. Also, special vacuum tube high-voltage arresters have been provided for installation at each substation.

The equipment, which is known as the synchronous relay type provides, on the traffic operator's control desk, a control key and indicating lamps for each device in each station for which supervisory control has been provided. Associated with these lamps and keys are groups or small multi-contact control relays controlled by the keys, mounted apart from the desk in a steel cabinet. A similar installation has been made at each substation. At the substation, however, the small relays in the cabinet, which are controlled by the operation of those in the cabinet at the dispatcher's station, are connected through their contacts to energise or deenergise auxiliary relays which in turn cause the devices in the substations to function in response to the operations at the control desk, initiated by the dispatcher.

Essentially the functioning of the system is as follows:—Two of the four wires in the control circuit provide a step by step circuit by which similar relays at each end of the line are operated simultaneously in such a way as to

keep a series of relays, each effecting the operation of the next relay in the series, in absolute synchronism. Each of these relays, which is provided with a group of contacts, is assigned to one particular control circuit in the substation and to the corresponding lamp and key circuits at the traffic operator's control desk. As each relay operates, a pair of its contacts are momentarily connected to the other two wires of the control lines.

If it is desired to operate any one of the circuits, the change in position of the control key arrests the operation of the chain of relays after it has progressed to that position in the sequence. Thus, the second pair of wires constitutes, through the contacts of the relay at each end of the circuit, a direct metallic circuit by which the auxiliary relay in the substation is energised or deenergised to effect the operation intended. Immediately following the functioning of the device, a lamp indication and an audible signal, showing that the device at the substation has operated, is returned through the same circuit, after which the relay chain is released to complete its sequence. Normally, all equipment in the supervisory system is at rest. It

functions only in response to operations initiated by the traffic operator, or the automatic operations of the substation equipment.

By means of this system, the traffic operator may open or close any of the main power circuits either on the primary side of the power transformers or on the supply from the direct-current bus to the third rail sections. Also, he is able to start or stop any of the machines in the automatic stations. In addition to control over breakers at various points on the system, through which power is supplied to the signal system, he has an indication of the position of the oil circuit-breakers on the 33,000-volt system, which are operated by the power company.

Power for the operation of the supervisory control equipment is supplied from small 48-volt storage batteries installed at each substation. Should the supervisory system, for any reason, fail to function, the stations remain under full automatic control. In addition to features which insure against faulty operation of the supervisory system, alarm circuits are provided to indicate open fuses, open circuits and short circuits on the line wires.

Hydroelectric Power Commission of Ontario

The annual report of the hydroelectric power commission of Ontario, Canada, for the year ended October 31, 1924, forms a bulky volume of progress records and statistical information. It covers all of the commission's activities and also embodies the financial statements of the municipal electric utilities operating in conjunction with the commission. Operations are dealt with in respect to nine systems, to which are connected 386 municipalities, including 131 townships and rural districts, and 93 industrial companies. The year has been the most successful in the commission's history. Notwithstanding the quiet industrial conditions there has been a considerable growth in the demand for power on nearly all systems, and arrangements are being made in the direction of new power developments. The sixth unit of the Queenston-Chippawa plant was put into operation early in the year, and two further units are now in course of installation. The Queenston plant has been linked up with the plants of the Electrical Development Co. and the Ontario Power Co., with resultant economy in operation. As an example of growth of load the city of Port Arthur, connected to the Thunder Bay system, may be cited. When the system first went into operation four years ago the load in the city was 7,000 h.p. During the last year the demand reached 21,000 h.p. The total average load on the system during

the year was over 27,000 h.p. and it is estimated that during the present year it will reach 40,000 h.p. One customer alone, the Great Lakes Paper Co., takes 12,000 h.p. In the Central Ontario and Trent system power is obtained from a number of developments on the Trent and Otonabee rivers. Two new generating stations of the automatic type are now under construction on this system. The distribution of power in the various systems is shown by the following table, which gives the 20-minute peak h.p. during the month of December, 1924.

System.	h.p.
Niagara system and export	662,311
Georgian Bay	15,529
Muskoka	1,582
St. Lawrence	5,112
Rideau	2,607
Thunder Bay	37,500
Ottawa	14,708
Central Ontario and Trent	39,222
Nipissing	2,218
	780,789

The total investment of the commission in power undertakings and electric railways is £38,005,000, and the investment of municipalities in distribution systems, etc., is £14,550,000. During the past year the commission's revenue from power sales totalled £3,379,570. After meeting all charges there was a net surplus of £145,140.

The Fullagar Oil Engine

The English Electric Co. Ltd. has recently taken up the manufacture of the Fullagar oil engine for such purposes as the driving of

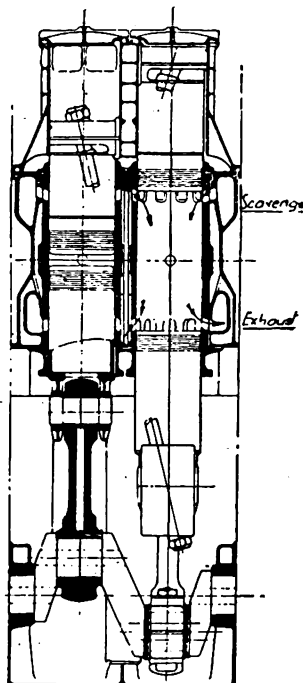


Fig. 1. Cross-section of Fullagar Engine Cylinders

electrical generators, pumps and compressors. The engine is of the opposed piston type, working on the two-stroke cycle and the Diesel principle.

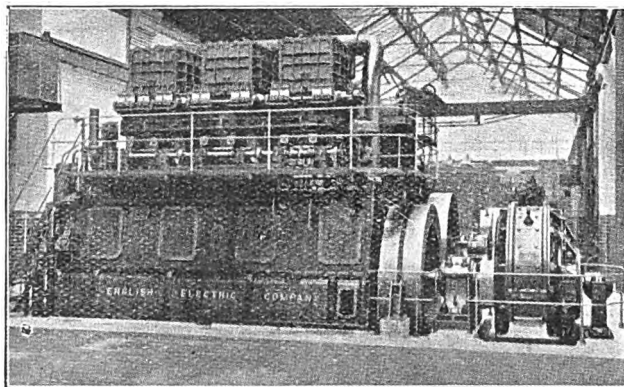


Fig. 2. 1,125 h.p. Fullagar oil engine driving d.c. generator

Its special feature lies in the use of only one crank and connecting rod per cylinder, although there are two pistons per cylinder. The arrangement which makes this possible is shown in

Fig. 1. Oblique rods are used connecting the lower piston in the first cylinder to the upper piston in the second cylinder, and the upper piston in the first cylinder to the lower piston in the second cylinder. Thus there are two pistons driving each crank. This design not only lends itself to compactness and rigidity and makes for a low weight-power ratio, but gives excellent balancing of the reciprocating parts. The opposed piston arrangement also allows of very complete scavenging of exhaust gases, for the ports can be arranged all round the cylinder so that one piston uncovers the exhaust and the other the air inlet. In the Fullagar engine the fresh charge is supplied under pressure.

The special field of the Fullagar engine lies in heavy drives where the ordinary Diesel type would be heavy and expensive. The weight of the Fullagar engine is 30 to 35 per cent less than that of an ordinary four-cycle engine of similar capacity, and the space occupied by an 1,125 h.p. Fullagar is no more than that required for a 500 h.p. Diesel. In addition the Fullagar engine has a conservative rating and is capable of continuous running for long periods. The engines are at present being built in two sizes, 750 b.h.p. and 1,125 b.h.p. Test figures on one of the smaller engines show a fuel consumption of 0.604 lb. per kw. hr.

PROJECTED 700,000 KW. GENERATING PLANT

The New York Edison Co. is planning a generating station for an ultimate capacity of 700,000 kw. to be erected at East River, New York. The initial installation is to be of 120,000 kw. capacity and the first units will consist of two 60,000 kw., 25 cycle, 11,400 volt G.E. turbo-alternators. In addition there will be a 40,000 kw., 25 cycle, 11,400 volt to 60 cycle, 13,800 volt, G.E. frequency changer installed in the engine room. Ten 1,550 h.p. Springfield water tube boilers equipped to burn pulverised fuel are to furnish steam at 375 lb. pressure and 700 deg. F. total temperature for the first turbine installation. For the future installations some of the boilers and turbines may be of the mercury type. The exact ratings of these have not yet been decided, although it is intended that seven more turbo sets of 60,000 kw. or larger be installed.

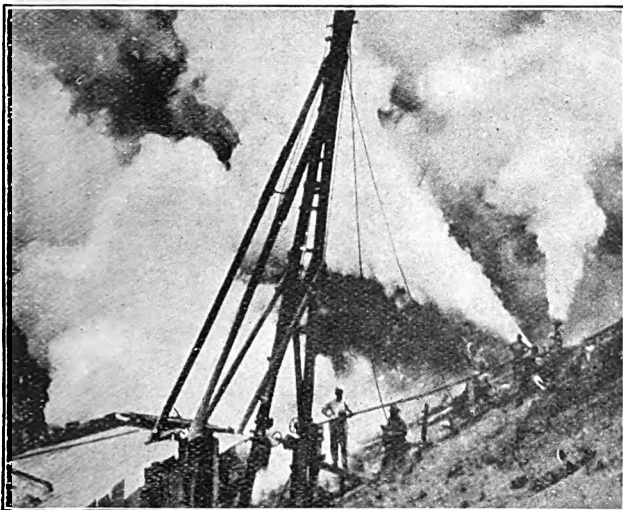
Electricity from Natural Steam

Geyser canyon in Sonoma county, California, located about 75 miles from San Francisco, has been utilised as a health resort for many years. It is peculiar not only for its hot springs and mineral waters, but owing to the large volumes of steam which escape from crevices in the ground. According to accepted theories this steam comes from a cavern of vast extent, which has for a floor a layer of spongy rock beneath which is a mass of molten lava. Water from surface lakes seeps down continually through numerous passages, percolates through the porous rock and is transformed by the intense heat into steam, which rises into the cavern. The constant escape of this steam through

However, in the case of Geyser canyon there appeared a possibility of achieving practical results. After a careful examination a company was formed for the purpose of drilling the ground and endeavoring to tap the hidden heat reservoir. Doubt was expressed in many quarters as to the wisdom of the proposal but the organiser, John D. Grant, persisted until success was achieved. Naturally there were unusual difficulties to be overcome. The first drilling had progressed to a depth of 140 ft. when the pressure caused an explosion that demolished the well casing and wrecked the well. Operations were started again at a new location, this time using eight-inch iron steam pipe for the well casing. At a depth of 75 ft. there was another explosion. Mud, water and rocks were thrown high into the air and there was a tremendous outburst of steam. But the iron pipe held fast and the drilling continued until, at a depth of 203 ft. a constant flow of steam was tapped. A five-inch steam valve was installed on the pipe and the well was considered complete.

The co-operation of the General Electric Co. was secured in examining the possibilities for electric power generation. The steam proved to be 99 per cent pure. It issued with a steady flow at a pressure between 60 and 70 lb. per sq. in. and temperature of 335 deg. F. The examining engineers considered that it might be possible to generate as much as 1,500 kw. per steam well, provided the necessary water supply for condensation could be obtained. As a preliminary step a 35 kw. G.E. turbo-generator was connected to the tap. This unit has since been supplying energy to light a nearby hotel and several cottages. Fifty feet from the first well, a second was drilled, reaching a depth of 318 ft. Well No. 1 supplied the power for drilling well No. 2. Although so close to the original well, the new tap has had absolutely no effect upon the steam pressure of the former. The tremendous resource of the underground steam chamber is indicated by the undiminished steam pressure obtained even when the turbo-generator was running at the same time that the steam engine driving the drill for the second well was operating.

Already a plan is in the making to supply electricity to Healdsburg, a town of 2,000 population about 15 miles from the canyon, but much experimenting will be necessary before a really practical installation will be possible. Engineers are now working to build a turbine of materials which will not be affected by the small percentage of gases found in the steam. It has been calculated that it would only cost about £15



Steam Wells, Geyser Canyon, California, U.S.A.

crevices and vents to the earth's surface prevents the pressure from rising to a value that might cause an explosion. Thus this underground chamber forms a reservoir through which heat energy from the interior of the earth may be tapped.

The possibility of making use of the earth's energy has been engaging the attention of scientists lately. Mr. E. W. Rice, junr., honorary chairman of the General Electric Co. of America, made mention of the subject in his paper on "New Fields of Research for Power Development," read before the world power conference. Sir Charles Parsons advocates boring a hole 10 miles deep into the earth in order to study the internal heat. But it is unusual to find ready-made facilities for using the earth's heat. Underground steam certainly is in evidence in many places, but its purity is usually questionable and there are in most cases other adverse conditions which preclude its use.

per kw. for an electric generating installation operated by natural steam, whereas either a small steam electric or hydroelectric plant would cost from two to three times as much.

This is, of course, not the first time that electricity has been generated from natural steam. At Larderello, in Italy, natural or volcanic steam has been at work for several years, in a series of plants, and part of the city of Florence is lighted by the resulting electricity. The steam is far less pure, however, requiring treatment in intermediate apparatus before going into the turbines, and the pressure is only half as great, averaging around 30 lb. per sq. in.

ELECTRICAL COOKING PROBLEMS

The "Electrical Times" publishes interesting extracts from a paper, read recently at Leeds, England, by Mr. R. H. Hardie, on some of the problems that have arisen in connection with electric cooking. The author describes the present situation in the electric cooking field and deals in a very direct manner with certain factors which are hindering the more extensive development of kitchen electrification. He lays principal stress on the fact that the advantages of electric cooking—excellent results, cleanliness, saving in labor, etc.—are all outweighed in the mind of the average householder by installation and running costs.

Mr. Hardie states with confidence that the electric cooker of to-day, quite distinct from the cooker of three or four years ago, is, in the hands of careful operators, satisfactory under all heads. Manufacturers have been able to profit from observation of stoves in service and have remedied the defects of the earlier types. The oven has been efficient and fairly satisfactory, for some time. The grill also has been satisfactory, and any recent improvements in these features have been in the nature of sturdier construction of elements and improved accessibility. The low temperature elements by which the modern oven is heated have a very long life under average conditions. In most types, the wiring and switching arrangements are now such that dismantling in case of necessity is quite a simple job.

The one serious technical drawback which has not yet been absolutely overcome is in the boiling arrangements. A hotplate thoroughly immune from damage through mechanical injury or from spilling liquids, and yet highly efficient, while reasonable in cost has not yet been designed. Recent improvements, however, are bringing this nearer accomplishment, as certain types of plate are giving very good service. The principal

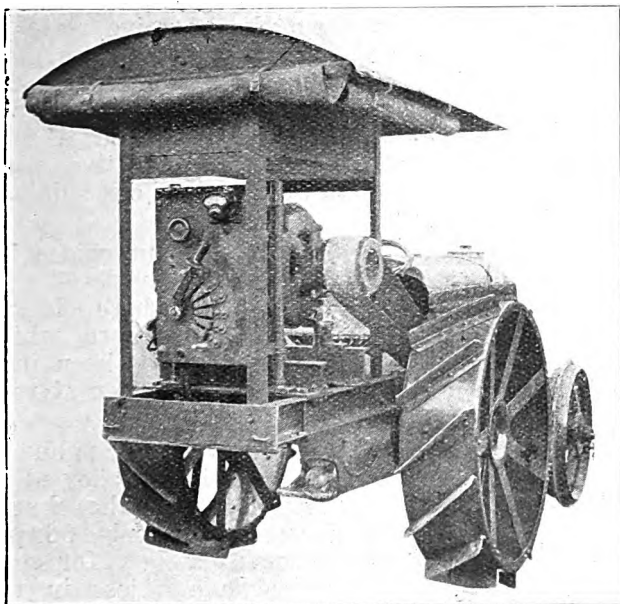
trouble is that electric boiling by means of hot-plates is slow. This has been largely overcome by the use of open type elements with loading up to 2,000 watts, but the efficiency is not altogether wonderful and the type is liable to mechanical damage. Mr. Hardie points out that the electrical industry is only following the lead of the gas industry. It is, perhaps, 30 years since the gas cooker was first put on the market, and then, not because it was cheaper to cook by gas than by the coal range, but mainly for reasons of convenience. Gas cookers are still being changed and improved in order to hold the public, and electric cookers must be similarly handled.

The biggest factor operating against electric cooking now is the cost. Electric supply authorities are doing a great deal to encourage the use of cookers by offering cheap tariffs in order to reduce the running costs, but they require the cooperation of the manufacturers and the selling organisations in bringing the first cost down to a reasonable level. It is little use telling a possible purchaser how much more convenient an electric stove is than a gas stove when the former costs three times as much as the latter. The cost automatically limits the field for sales. There is no valid reason for the present high prices of electric cookers. Development has now proceeded to such a point that a manufacturer can choose one or two standard designs and set about scientific production with a view to reducing costs. There is no real call for a very small cooker as even for a household of two to four persons practically the same accommodation is required as for a somewhat larger household. The size of the oven, which determines the overall dimensions of the cooker is practically constant. The grilling accommodation cannot be cut down. The only possible variation is in the boiling equipment. It appears that a stove designed to cook for about six persons should cover a very wide field.

Mass production has reduced costs on electric fires and irons and there is no reason why it should not be applied to cookers. Mr. Hardie states that no factory for mass production of cookers alone exists to-day. Electric cookers are treated by the majority of firms as a side line, and probably no manufacturer employs a staff whose constant duty it is to endeavor to improve the product. There are other instances of electrical appliances where excessive cost restricts use, such as vacuum cleaners and clothes washers. Even with the aid of easy payment schemes, these will never at to-day's prices reach one-tenth of the homes where their services are so badly needed. The preliminary developmental stage in the manufacture of these appliances is at an end and there is now no reason why production can not be got down to a basis that will at the very least cut costs in half.

Portable Arc Welding Outfit

The process of electric arc welding has been so developed that it is now used in nearly all operations where iron or steel are to be joined, built up, or cut. The general adoption of the arc welding process has resulted in leading manufacturers of electrical machinery devoting particular attention to the development of electric generators possessing the special characteristics required for this purpose. The Australian General Electric Co. Ltd. has recently constructed some equipment of a new type in the form of a



Portable Arc Welding Outfit

portable welding outfit. Three of these equipments have been supplied to the Melbourne and metropolitan board of works for arc welding the joints in pipe lines conveying water from certain of the metropolitan reservoirs, and one was supplied to the South Australian railway department for outside construction and repair work. Each outfit consists of a G.E. type WD, constant energy, single operator arc welding generator mounted on a Fordson tractor and belt driven from the tractor engine, which is rated at 22 h.p. The general arrangement is clearly shown in the illustration. In addition to driving the generator, the tractor is, of course, self-propelling and is capable of attaining a speed of six to eight miles per hour on the level. This type of equipment was selected because of its ability to negotiate rough ground and the steep grades which are encountered along the pipe lines in hilly country.

The type WD constant energy, self-excited arc welding generator has been developed by the General Electric Co., U.S.A., for metallic welding

work, and possesses all the characteristics demanded by arc welding service. An external ballast resistance is not used with these generators. Since they are self excited, no direct connected exciter is required and the voltage characteristic is such that throughout the proper working range of the arc the energy delivered is practically constant for a given current setting, resulting in a uniform rate of deposition of metal. The voltage and current follow the momentary variations in the arc and, consequently, the lag between change in arc conditions and resulting corrective change in electrical conditions is reduced to a minimum. The generator is so wound as to give a no-load or striking voltage for metallic welding of 60 volts, which, when the arc is struck, automatically and instantly decreases to the voltage required by the arc. The normal arc voltage is from 18 to 25 for the average operator and work. A longer arc and higher arc voltage are undesirable, since poor welds are apt to result.

The switchboard panel controlling the generator carries a voltmeter for measuring the voltage across the arc, a shunt field rheostat for adjusting the arc voltage to suit various types of electrodes, and a dial switch for adjusting the welding current. By means of the dial switch, which is clearly shown in the illustration, the arc current may be adjusted from a maximum of 200 amps to a minimum of 75 amps in 25-amp steps. The actual power required to drive the generator on full load is only $7\frac{1}{2}$ h.p. The generator and switchboard are housed under a sheet steel canopy, which is provided with weather-proof canvas side screens to protect the electrical equipment. A tool box to carry the electrode holder, welding cable, and accessories is provided under the canopy.

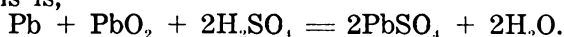
WAVE POWER

A company, to be known as Bates Wave Power (Aust.) Ltd., with capital of £100,000, is being formed in Sydney to exploit the invention of Mr. P. Bates for generating electric power from the energy of sea waves. Mr. Bates has erected an experimental plant to demonstrate his ideas. The wave energy is converted into mechanical power by leading the water through a canal from the shore. Suspended above the canal is a pendulum with a flat plate immersed in the water. The pulsation of the waves in the canal actuates the pendulum which is connected to a small pump elevating water to a tank on an adjacent hill. From the tank the water runs down again driving a small turbine to which is coupled an electric generator.

An Improved Type of Accumulator

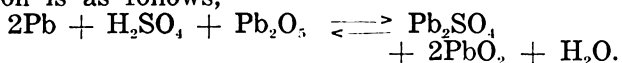
The limitations of the ordinary lead accumulator are well known. Slight misuse in respect of the rates of charge and discharge is liable to impair the efficiency of the cell by producing buckling of the plates and sulphation, whilst if the cell is allowed to remain in a discharged condition for any length of time, similar deleterious effects result. In addition to this it is found that a fully charged cell, if allowed to stand, will in time lose a large proportion of its charge spontaneously. Nickel accumulators have to some extent overcome these difficulties. Any advantages they may possess in this respect, however, are counterbalanced by their lack of the most important property of the lead cell, that of maintaining a steady electromotive force over a long period. Consequently, it is of interest to find in a recent paper by M. Ch. Fery* an account of researches in which the author set himself the task of devising a lead accumulator, using immobile materials, which was incapable of being sulphated or damaged by misuse.

He commenced by a theoretical study of the chemical changes taking place on charge and discharge, and his results have led him to reject the usually accepted theory of sulphation. In its simplest form the usual equation representing the total reaction during the discharge of these cells is,

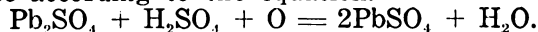


When a cell becomes sulphated the reaction represented by the reverse equation cannot take place, and the cell cannot be recharged. This has been attributed to a change in the condition of the lead sulphate, which assumes a more inert form.

On the other hand, M. Fery's reversible equation is as follows,

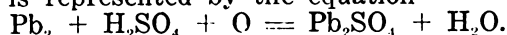


It appears from this that during a normal type of discharge plumbous sulphate is produced, and it is only by accident that the familiar white divalent salt results. This action may take place according to the equation.



Thus it is due to the presence of excess oxygen. The Pb_2O_3 on the positive electrode is a black peroxide, and a powerful oxidising agent. The plumbous sulphate is dark grey in color and is a conductor, whereas the white lead sulphate is not.

In a similar way, the spontaneous discharge may be explained by the combined action of the electrolyte and the oxygen on the negative plate. This is represented by the equation



This is a normal type of discharge, but in the course of time may proceed a stage further in the way described above. Thus,



The cell has then become sulphated and cannot be recharged.

If this is true, the obvious remedy is to remove the negative plate from the action of the oxygen, and so prevent the formation of the divalent lead sulphate. This is what M. Fery has done. He recognised that the oxygen may come from the air or the positive plate or from both, and may be kept away from the negative plate by placing the latter at the bottom of a deep glass vessel. A porous substance containing the electrolyte further isolates the plate from any sources of oxygen. When the discharge commences, the darkening of the negative plate owing to the formation of the plumbous sulphate is plainly seen.

The advantages claimed by the author for his new type of cell should render it capable of wide application in practice. It has a high electromotive force and low internal resistance, whilst it can be recharged cheaply. As has been indicated above it maintains its charge when at rest, and cannot be sulphated.

Somewhat stringent tests have been applied to this new cell. It was charged and allowed to stand for twenty-six months, when the charge was found to have decreased by only 66 per cent. Allowing an exponential law for this spontaneous discharge, we have a loss in the first month of only 4 per cent. After four months, the time in which an ordinary accumulator would have lost all its charge, as much as 83 per cent remained in the new cell. Finally, a cell was allowed to stand for two years in a fully discharged state, and at the end of this time it could be recharged again, and its subsequent behavior appeared in no way to be affected.—(Chemistry and Industry.)

COLLIE POWER PROPOSAL

A deputation which waited on the premier of Western Australia recently, urged the erection of a power station on the Collie coalfield to supply energy to Collie, Bunbury and the intermediate districts. The scheme is estimated to cost £216,650, and such a station would form the nucleus of a plant that might be expanded to 150,000 kw. capacity as the demand arose. The government is being asked to contribute half the cost.

*Comptes Rendus, 1924, 179, 1153.

Victorian Electricity Commission Enquiry

The state electricity commission of Victoria, which was appointed in 1918 for the purposes of developing power resources for the benefit of the community and of controlling electricity supply throughout the state, has made very considerable progress in carrying out its duties. The principal works executed to date are: (1) The opening up of portion of the brown coal deposits to the south of the Latrobe river at Yallourn and the establishment of a briquetting factory; (2) the laying down of a power station of 62,500 kw. capacity burning brown coal at Yallourn, with transmission lines to Melbourne; (3) the establishment of a 30,000 kw. peak load power station in Melbourne; (4) the installation of a primary distribution system for the supply of electrical energy in the Melbourne metropolitan area; (5) the erection of an extensive system of transmission lines supplying power in Victorian country districts; (6) the reticulation and retailing of energy in numerous towns. The expenditure of loan money in these several works and in certain minor undertakings is in the neighborhood of £8,000,000. The commission is now asking for a further sum, approximating £1,000,000, for the establishment of a 24,000 kw. hydroelectric undertaking on the headwaters of the Goulburn river.

During the seven years of its existence the commission has launched on many undertakings that were not under consideration when the original estimates were drawn up. As a consequence capital expenditure has been continually on the increase. This fact, coupled with the circumstance that the commission has not seen fit to publish periodical detailed statements re-

garding its activities, has given rise to a good deal of public questioning as to whether the money was being spent to the best advantage. In addition, criticisms regarding certain technical features in the commission's activities have been made from time to time. The replies of the department to questioning have not always been clear on the various issues raised, and consequently feelings of distrust and apprehension have arisen in the public mind. Whether these feelings are well-founded or not remains to be seen, but an endeavor is to be made shortly to clear up the matter. The government is about to appoint an independent expert or a board to enquire into the whole of the commission's activities.

Such an enquiry board has been demanded in certain quarters for some time, but the final request which caused the government to take action came from the commission itself. In a letter to the attorney-general the commission say: "While it is realised that criticism is not unusual in the experience of those responsible for the conduct of public undertakings, and the personnel of the commission is not unduly disturbed thereby, the commission is nevertheless very much concerned in as far as such criticism is undoubtedly calculated to destroy public confidence in the scheme and in its administration, and seriously to hamper its further successful development and operation." This is, of course, very true. But will the result of the enquiry be to restore public confidence? The commission, in asking for the enquiry, infers that it will. A great deal depends on the personnel of the board of enquiry and its scope.

Sydney City Council's New Power Station

The Sydney city council has selected an area of 70 acres of land at Bunnerong, on the north side of Botany bay, about seven miles from the centre of Sydney, for the erection of its proposed new power station. Nearly half of the area is below high water mark in a shallow corner of the bay. The portion above high water mark rises steeply from the shore to a height of about 50 ft. Such portion of this as is required for buildings and yard space will be cut down to a level about four feet above high spring tide. The rock taken out will be used to construct a sea wall enclosing the portion of the bay to be reclaimed. When the wall is completed sand will be pumped into the enclosed

portion from the bottom of the bay until the level is raised to the same height of four feet above spring tide. The total frontage to Botany bay will be about 2,500 ft. Boring is proceeding on the site, but enough has already been done to prove good rock at a convenient depth at every point where foundations for plant, columns, etc., will be placed.

The shore of Botany bay runs southward from the site for a few hundred yards to Bumborah point, from which it tends north-easterly into Yarra bay. Circulating water for the condensers will be brought to the site by two tunnels from Yarra bay. The distance from the bay to the screening chambers will be about five hundred

yards and the discharge from the condensers will enter Botany bay about five hundred yards from Bumborah point on the other side of the point from Yarrah bay.

The site is to be laid out to accommodate a plant of 300,000 kw. capacity, but the construction will be carried out in three sections and one section only, of 100,000 kw. capacity, will be built at first. In this section the generating plant will comprise six turbo alternators with a maximum continuous rating of 25,000 kw., each on a power factor of .75. The turbines will have their point of lowest steam consumption per kw. h. under specified conditions at 20,000 kw. The generating voltage has tentatively been fixed at 11,000, but as all the energy generated will be stepped up to 33,000 volts, this figure may be amended. Each alternator will be directly and permanently connected to a step-up transformer (or group of transformers), and all switching will be done at 33,000 volts. The switchgear will be housed in a separate isolated building. The first section will provide control for the six 25,000 kw. alternators and for 36 feeders besides six circuits supplying auxiliaries.

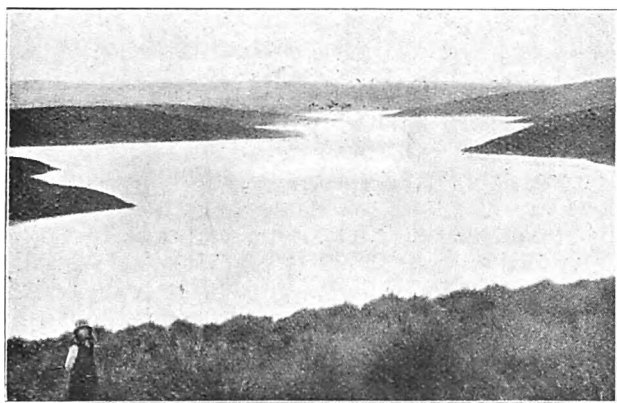
Steam will be supplied by 18 boilers, rated at 100,000 lb. per hour each, arranged in six banks of three. Six boilers will form a unit with two turbo-alternators. At first coal will be delivered at the site by rail. Later delivery by water will be considered. To provide for

taking delivery of seaborne coal considerable harbor works are required which will not be undertaken at present. A new road to the site is to be constructed, and the railway commissioners have agreed to build a spur railway line at the council's expense to give access to the station. It is expected that when the station is in full working order about 450 men will be employed. The council proposes to acquire additional land for the erection of houses for these employees. It is estimated that the first section of the station will cost £2,000,000.

The greatest demand on the Sydney council's electricity supply up to date was about 72,000 kw. in August, 1925. Of this about 53,000 kw. was carried at the council's Pyrmont power house and the balance purchased from the New South Wales government railway department. By 1930 it is estimated that the demand will be about 150,000 kw., of which 100,000 kw. will be supplied from the new Bunnerong power house, and 50,000 kw. from the existing Pyrmont power house. Under an agreement the increase in the demand on the council's system in the year 1926 and the year 1927 will be met by increasing the draft on the railway department's system. From 1928 onwards the increases in demand will be supplied from Bunnerong, and by 1930 or earlier the purchase of energy by the council from the railway department will cease.

Electric Supply at Dunedin, N.Z.

The city council of Dunedin, N.Z., operates a hydroelectric station of 9,000 kw. capacity, situated at Waipori falls, 30 miles from the city.



Lake Mahinerangi

The original plant was put into operation in April, 1907. There is also a crude oil driven plant of 860 kw. capacity situated in the city itself. During the early part of the year ended

March, 31, 1925, there was a serious shortage of power owing to prolonged dry weather causing a depletion of the water shortage. This experience and, paradoxical though it may seem, the experience of a heavy flood in April, 1923, impressed upon the council the necessity of considerably increasing the height of the Waipori dam in order to obtain larger storage capacity and to give better regulation of the river flow. It was decided that the wall be raised from a height of 40 ft. to 110 ft. above the river bed, giving a storage capacity of 198,000 acre feet. The corresponding rise in the level of the water backed up, which forms Lake Mahinerangi, would, of course, submerge a considerable area of land, and negotiations were therefore opened with landholders and the holders of mining leases in the area with a view to arriving at reasonable bases for compensation. The various claims were finally adjusted for an amount slightly over £50,000, more than half of which is to be paid to a firm of station owners whose homesteads and a large portion of whose property will disappear. In addition it has been agreed that the dam will not be raised above a height of

60 ft. until after March, 1928. A clause in the act which gives the council power to increase the water storage practically prohibits mining on any portion of the watershed after Sept. 30, 1925, as it will be unlawful to discharge into the Waipori river, or any of its tributaries above the dam, any debris, waste water, etc. This is important as it settles the problem of silting-up. In addition Lake Mahinerangi is to be beautified by systematic afforestation. An area of about 60 acres has already been planted with pinus insignis and Douglas fir and much larger areas are to be planted during the current year.

In connection with the operation of the present plant it is noteworthy that the total time lost during the year was only 4 hours 10 minutes. Of this, two hours was due to trouble with the water tunnel. No stoppage has been caused by insulator trouble on the transmission line. A new generating unit, consisting of a 5,500-h.p. Boving turbine coupled to a 3,000-kv. G.E. alternator, was put into service in July, 1924. The connected load is increasing rapidly, the increase in applications for electric heaters being most marked. The advantages of electric cooking also have been placed before the public and the response has been distinctly promising. There are now 31 ranges and 40 water heaters in operation and giving every satisfaction.

At the close of the financial year extensions to the plant were in course of construction. The preliminary work in connection with raising the dam was in hand and a second 3,000-kw. unit was being erected. The erection of this set involved the removal of one 1,000-kw. set, so that the capacity of the station upon completion of the work will be 11,000 kw. Extensions to the Halfway Bush substation were completed and 6,600-volt primary distribution was commenced. A 4,500-kv.a. synchronous condenser for this substation is on order. Reticulation is being carried out in the farming district of Taieri, where about 50 milking plants scattered over a wide area are to be supplied. A single phase low tension system has been adopted for this district and it is anticipated that a good power and cooking load will also be developed.

The report of the city electrical engineer, Mr. M. C. Henderson, gives statistics of operations during the years ended March 31, 1924 and 1925, as follow:—

	1924	1925
Units sold	21,701,940	23,120,680
Total kw. connected	26,698	29,463
Number of consumers	14,000	15,412
Number of motors connected	1,723	1,901
Total h.p. of motors connected	14,171	14,970
Revenue	£120,886	£130,186
Working costs	46,346	47,328
Interest	32,887	36,681
Renewal fund	17,454	18,160
Depreciation	6,503	7,129
Net profit	17,636	20,883

SYDNEY CITY COUNCIL ELECTRIC SUPPLY

The annual report of the general manager of the electric supply department, Sydney city council, covers the activities of the department during the year ended Dec. 31, 1924. The council gives retail supply of electrical energy in the city of Sydney and in 34 suburbs, covering a total area of 155 sq. miles, with population of 807,000. It also gives bulk energy supply to the local bodies controlling seven other suburban districts, with total area of 456 sq. miles and population of 79,000.

During the year a considerable amount of work was carried out on extensions to the power station plant. Two new turbo-alternator sets were installed: one a 17,500-kw. machine built by Messrs. Thompson and Co., Castlemaine, Victoria, under license from the Metropolitan-Vickers Electrical Co., and the other of 12,000-kw. capacity, supplied by the British General Electric Co. Three new boilers also were installed, together with coal and ash handling plant, thus completing the equipment of boiler houses F and G. In connection with the rearrangement of plant the whole of the 10,000-volt transformers and switchgear were removed from the engine room to a new position in the switch house. The distribution system was considerably expanded. Six 5,000-volt, one 10,000-volt, and one 33,000-volt feeders were put into service between the power house and the first substation. On the low tension side 168 miles of overhead and underground mains were put into service. Additions to street lighting mains also were made, totalling 55 miles. A complete rearrangement of the feeder protective system is being made, and during the year tenders were accepted for the necessary relays, current transformers, etc., to provide a comprehensive system of graded overload, leakage and reverse power relays, with earthed neutrals, for the 5,000 and 10,000-volt systems.

Statistics covering the operations of the department during the years 1923 and 1924 are given in the following schedule.

	1923	1924
Units generated	176,268,800	199,645,000
Units purchased	16,557,560	21,865,420
Units sold	157,696,760	188,425,930
Maximum demand kw.	51,290	60,080
Maximum demand on railways system kw.	—	12,400
Load factor %	44.03	44.39
Coal consumed tons	189,780	206,080
Average B.th.u. per lb. of coal	11,426	11,250
Coal per kw. h. generated lb.	2.41	2.31
No. of consumers	92,213	112,563
Total capital expenditure to Dec. 31	£6,118,520	£6,858,250
Capital expenditure during year	890,810	739,730
Gross revenue	1,352,819	1,611,767
Working expenses	740,893	841,829
Capital charges	518,164	562,668
Net profit	93,762	207,270

Western Australian Government Electric Supply

The generation of electrical power for the city of Perth and its environs is in the hands of the Western Australian government. The energy is supplied in bulk to numerous local bodies which include the Perth city council, the Perth tramways and the Fremantle municipal lighting and tramway board. The power station is situated at East Perth and contains one 7,500 kv.a. and three 4,000 kv.a. turbo-alternator sets. Transmission and primary distribution is carried out at 20,000 and 6,000 volts, while secondary distribution is at 440/250 volts, 40 cycle, three phase. The report of operations of the undertaking for the year ended June 30, 1925, reveals a loss of £2,124. This adverse result is due to an unfortunate position that has arisen in connection with the selling price of energy to certain consumers. When the station was designed in 1912 it was estimated that, on the basis of an output of 12,000,000 units per annum, the cost of energy would be .54d. per unit. For the success of the scheme it was necessary that certain large consumers take their supply from the station, and the Perth and Fremantle municipal authorities were therefore induced, by offers of favorable rates, to scrap their existing generating plants and take the whole of their supplies from the government station. Under the respective agreements the Perth council gets its energy for 50 years from 1912 at a maximum cost of .75d. per unit, and the Fremantle council obtains supply for 25 years from 1916 at .85d. per unit. Due to unforeseen causes, principally the necessity of installing plant to cope with a greatly increased demand, now in the neighborhood of 48,000,000 units per annum, and the increase in costs brought about by the war, the cost of generation has now risen to 1.02d. per unit. The result of this is that the government lost nearly £30,000 in the last year in connection with its contracts with these two consumers alone.

During the year also, the price at which energy is debited to the Perth tramways, which are operated by the government, was reduced. The rate had been 1.5d. per unit, but in view of the fact that energy is supplied to other consumers at 1.25d. it seemed inequitable to charge the tramways a higher rate. The reduction to the lower figure is, therefore, being made, but in order not to unduly upset the existing financial arrangements it was only brought into effect during six months of the past year.

There has been no extension to the power station plant during the year although certain renewals, notably in stoker drives, have been made. It is noteworthy that the 7,500 kw. Parsons set was responsible for 76.5 per cent of

the total power generated during the period. This set ran for 8,099 hours, or 92.4 per cent of the possible time. The boiler plant is now fully loaded. Contracts have been let for extensions to both generating and boiler plant, comprising the installation of a 12,500 kw. turbo-alternator, a 500 kw. house turbine set and two 65,000 lb. per hour boilers. Considerable additions to the power station buildings are involved in these extensions and the estimated cost of the works authorised is £239,950.

Technical and financial data covering the operations for the last two years are given in the following schedule:—

	1924	1925
Plant capacity	19,500 kw.	19,500 kw.
Maximum demand	11,500 "	12,400 "
Load factor	44.75 %	47.2 %
Units generated	45,188,910	51,188,230
Units sold—		
Perth tramways	8,061,920	8,296,746
Perth city council	17,980,728	21,308,941
Fremantle tramways	7,089,338	7,279,778
A.c. bulk supplies	5,427,304	6,218,508
Low tension supplies	541,417	1,008,888
Total	39,100,707	44,112,861
Coal used—		
Colliie small	64,502 tons	74,936 tons
Imported	55	54
Coal used per unit generated	3.20 lb."	3.28 lb."
Gross earnings	£166,210	£185,190
Working expenses	116,150	133,805
Interest	37,260	40,040
Antiquation	12,370	13,470
Balance—		
Surplus	430	—
Deficit	—	2,125
Working expenses per unit sold	.71d.	.73d.
Capital charges	.31d.	.29d.
Total cost	1.02d.	1.02d.
Average selling price per unit	1.005d.	.996d.

KALGOORLIE TRAMWAYS

The tramway system in Kalgoorlie, W.A., is operated by the Kalgoorlie Electric Tramways Ltd. There is a route length of 19 miles of 3 ft. 6 in. gauge track and the rolling stock comprises 25 motor cars and seven trailers. The trolley system is operated at 500 volts d.c. The report of the company for the year 1924 shows a decrease in traffic receipts as compared to the previous year. This is accounted for by the depressed condition of business of every description in Kalgoorlie and by motor bus competition. Statistics of operations during the last two years are as follow:—

	1923	1924
Car mileage	299,455	286,990
Passengers carried	1,927,403	1,729,410
Units consumed	436,089	429,340
Gross revenue	£28,920	£26,080
Net profit	£7,445	£5,150
Receipts per car mile	22.21d.	20.70d.
Operating expenses per car mile	15.16d.	15.39d.

Melbourne Electric Railways

The report of the Victorian railways commissioners for the year ended June 30, 1925, shows a net credit balance of £25,942 on the operations of the whole steam and electric system. The gross revenue amounted to £12,692,145. Added to this is an amount of £138,138 appropriated by parliament and paid to the department, principally in respect of losses sustained on certain non-paying lines. The working expenses totalled £9,485,845, interest charges amounted to £3,099,885, pensions and gratuities accounted for £215,087 and adjustments in respect of certain lines amounted to £3,524.

On the suburban electrified system there has been somewhat of a falling off in traffic as compared to the previous year. This may be accounted for to a certain extent by the fact that last year the traffic was extraordinarily heavy owing to the visit of the British naval squadron and to a strike on the tramways. But at the same time it is undoubted that there has been a check in the development of the traffic, which may be accounted for by increasing competition from the trams and from motor bus services. Despite the reduction in passenger journeys the revenue has increased somewhat, showing that the frequent and fast services given under electrification are inducing people to live further from the city centre. During the year the running of seven-car instead of six-car trains was resorted to during rush periods on the important lines. Extensions to the electrified system are being made by changing over from steam to electric traction on sections of lines outside the suburban area. The line between Ringwood and Croydon has already been dealt with in this manner, and similar work is now nearing completion on the Croydon to Lilydale and Ringwood to Upper Ferntree Gully lines. For these last sections two automatic substations are being erected, in which mercury arc rectifiers are being installed instead of the usual rotary converting machinery. There are already several automatic rotary subs. on the system, which have proved highly satisfactory in service. Probably the next line to be electrified will be the section between Eltham and Hurstbridge. In these country extensions wooden poles are being used for the catenary wire supports in lieu of steel supports.

The department operates two lines of electric tramways in addition to its railway undertakings. One of these runs from St. Kilda to Brighton, a route length of 5.18 miles, with 5 ft. 3 in. gauge, and the other runs from Sandringham to Black Rock, a distance of 2.21 miles, with 4 ft. 8½ in. gauge. During the year the former earned a net profit of £185, while the latter incurred a loss of £2,977. Both these results show considerable

improvement over the previous year's working.

Electrical energy for train and tram operation is supplied from the Newport A power station, which has a total generating capacity of 65,000 kw. During the year the units generated totalled 261,000,000, while an additional 4,600,000 units were taken from the system of the Victorian electricity commission in order to augment the supply. The railway department operates the 30,000 kw. Newport B power station on behalf of the electricity commission, the two stations being contiguous, but not directly electrically connected. Technical and financial statistics of the operations of the railway commissioners' electric traction undertakings are given in the following schedule:—

Electric Railway System	
No. of passenger cars	798
No. of electric goods locomotives	2
Passenger train mileage	7,194,731
Passengers carried	156,678,519
Passenger earnings	£2,616,965
Earnings per passenger mile	.69d.
St. Kilda-Brighton Tramway	
Car mileage	562,220
Passengers carried	5,737,101
Gross revenue	58,038
Working expenses	48,942
Interest	8,911
Profit	185
Sandringham-Black Rock Tramway	
Car mileage	127,962
Passengers carried	1,475,261
Gross revenue	£13,048
Working expenses	10,699
Interest	5,326
Loss	2,977
Newport A Power Station	
Units generated—	
Traction and train lighting	137,831,329
Other departmental services	11,252,914
For bulk industrial supplies	99,405,751
Operating costs	£428,502
Freight on coal	45,716
Interest	72,534
Average cost per unit generated	.528d.

ARAPUNI HYDROELECTRIC WORKS

Good progress is being made by Sir W. G. Armstrong, Whitworth and Co. in their contract for the hydroelectric development at Arapuni on the Waikato river, N.Z. Road connection has been made with the nearest railway station, Putaruru, nine miles distant. A quarry is being opened up at Muku, nine miles from the dam site, and an aerial ropeway capable of delivering 40 tons of stone per hour is being erected between the two points. The diversion tunnel, which is 832 ft. in length and will be 24 ft. diameter has been driven and is being enlarged to its final dimensions. In about two months' time the river will be turned into this tunnel and the bed laid bare for the dam construction.

MUNICIPAL TRAMWAYS, DUNEDIN, N.Z.

The Dunedin municipal council operates an electric trolley car system with single track length of 26 m. 45 ch. in the city, and two cable routes, one with a length of 2 m. 40 ch. to Mornington, and the other 4 m. 15 ch. in length to Roslyn. During the year ended March 31, 1925, a short extension to the electric services was opened. Electric drive is being installed on the Mornington cable route and this will enable a more frequent and faster service to be run. Improvements are also being carried out on the Roslyn route. The report of the tramways manager, Mr. W. H. Mackenzie, gives statistics as follow:—

	1924	1925
Passengers carried	19,482,997	19,729,985
Car Mileage	1,536,573	1,546,910
Total revenue	£126,407	£129,714
Working expenses	85,906	85,170
Interest	17,499	18,282
Renewal and accident funds	13,174	13,753
Depreciation	2,998	2,998
Net profit	6,830	9,511
Electric Lines—		
Operating expenses per car mile	13.42d.	13.21d.
Receipts per car mile	19.74d.	20.12d.
Mornington line—		
Operating expenses per car mile	18.2d.	16.29d.
Receipts per car mile	30.67d.	29.65d.
Roslyn line—		
Operating expenses per car mile	17.39d.	16.74d.
Receipts per car mile	24.72d.	24.86d.

PERTH TRAMWAYS

The tramway system of Perth, W.A., is operated by the state government. There is a single track length of 47 miles of 3 ft. 6 in. gauge track, and the rolling stock comprises 62 four-wheel and 51 bogie cars. The cars are operated from a 550 volt d.c. trolley, the power being supplied through converter stations from the government power station at East Perth. During the year ended June 30, 1925, the track length was extended by over three quarters of a mile and certain alterations in routing were made. A considerable amount of maintenance work also, involving track relaying and renewal of trolley wires, was carried out. In order to improve the power supply a new rotary converter was installed in the Cook street substation. The operating results for the year show that a net profit of £769 was made on the working of the system. The previous year's operations showed a loss of £155. During the year an adjustment was made in the price at which current from the government power station is charged to the tramways. The figure had been 1.5d. per unit, but this seemed unduly high in view of the fact that other consumers were only being charged 1.25d. A reduction was accordingly made to 1.25d. per unit, but in order to avoid

undue disturbance of the financial results of the two undertakings this only operated during two quarters of the year. The following tabulation gives statistics of the tramway operations for the past two years:—

	1924	1925
Car miles run	2,989,090	3,040,505
Passengers carried	27,893,315	28,894,525
Energy units consumed	8,061,920	8,296,746
Gross revenue	£274,583	£281,612
Total working expenses	231,895	236,008
Interest	42,843	44,835
Balance—		
Deficit	155	—
Surplus	—	769
Revenue per car mile	22.05d.	22.23d.
Working expenses per car mile	18.62d.	18.63d.
Earnings per passenger	2.33d.	2.29d.

SUGARLOAF HYDROELECTRIC SCHEME, VICTORIA

The Victorian electricity commission is pushing ahead with the preliminary arrangements in connection with the Sugarloaf hydroelectric scheme. The scheme involves the construction of six power stations along the headwaters of the Goulburn river. There will be an 18,000-h.p. station, containing two sets, at the Sugarloaf irrigation reservoir, one of 12,000 h.p., with two sets, at Rubicon, a 5,100-h.p. plant at Snob's Creek, a 3,600-h.p. station at Lower Rubicon, and units of 1,000 and 400 h.p. respectively at Royston and Rubicon Falls. The maximum output of the complete scheme is estimated at 24,000 kw. Automatic and supervisory control will be employed in the operation of the smaller stations. The combined power houses will give supply to the northern and north-eastern portions of the state and to some of the New South Wales border towns. In addition, a portion of Melbourne's demand will be supplied over a transmission line terminating north of the city at Thomastown. This line is already nearing completion, and until the hydroelectric scheme is put into operation it will give supply for the north-eastern demand and for construction purposes on the hydroelectric works from the Yallourn and Newport B power stations.

The country in which the hydroelectric stations are to be located is very rough and difficult and there are many awkward problems to be dealt with in the construction. It is estimated that about 13 miles of concrete water races will be built, in addition to pipe lines which will require about 1,250 tons of steel piping and 1,200 c. yd. of concrete. The work will include 130,000 c. yd. of excavation and 6,500 c. yd. of concrete work. Tenders for the supply of turbines, generators, transformers and switch-gear are shortly to be invited.

THE MONOWAI POWER SCHEME, N.Z.

The electric supply undertaking of the Southland power board, New Zealand, has been referred to as unique in that it serves a sparse population scattered over a wide area. The energy is generated in a hydroelectric plant of 4,000 kw. initial capacity at Lake Monowai. The scheme has been completed to the present stage at a cost within the original estimate, but, owing to the lightness of the loading, it has been found necessary to strike a rate of 1½d. in the pound in order to maintain the undertaking. When the board's proposal was first put forward a poll of ratepayers was taken on the question of raising the necessary loan, and only 6,530 out of 16,540 ratepayers voted. The striking of the rate, however, has dispelled the apathy and there is a strong agitation to have the control of the scheme handed over to the government.

NEW ZEALAND ELECTRIC SUPPLY REGULATIONS

A conference of electric supply engineers from all parts of New Zealand was held recently in Wellington to consider the question of unification of the rules and regulations governing the supply of electricity. Engineers representing the public works department and the post and telegraph department were present. The chairman, Mr. H. F. Toogood, pointed out the desirability of a uniform set of regulations governing electrical matters. At present there are three bodies controlling the erection and operation of electrical lines: the public works department, the post and telegraph department, and the railways department.

The following resolutions were passed by the conference:—

(1) That a standard set of rules for installation be drawn up by a committee representing the public works department, electrical supply authorities, New Zealand Electrical Contractors' Federation, and the Fire Underwriters' Association, the rules to be known as "The New Zealand Rules for Electrical Installations."

(2) That an association be established on the lines of the National Electric Light Association, this association to include both engineering and clerical branches.

(3) That supply authorities throughout New Zealand have uniform general terms and conditions of tendering and contracting.

The questions of setting up boards for the licensing of wiremen and for the inspection of electrical fittings and appliances were also raised. Legislation in the former matter is already in hand, and the authorities are considering the

establishment of a bureau of standards which would probably deal with the latter.

The suggested permanent organisation of electrical engineers would cover: (1) The full range of all technical matters, with an attempt to standardise rules and regulations, types of construction, and specifications, and to bring about the highest degree of efficiency compatible with proper economy. (2) The development of the sale of current on proper business lines.

ELECTRIC POWER BOARDS' ASSOCIATION

The third annual conference of the Power Boards' Association of New Zealand was held at Wellington on August 5. The president, Mr. J. A. Nash, in his address, paid a tribute to the assistance given to the boards by the minister for public works. He stated that the association was making good progress and now had a membership of 40. The prime minister, Hon. J. G. Coates, said that the power boards' act was working well, and the balance sheets of the various boards showed a great improvement during the last twelve months. The policy of the government was to supply electricity right throughout the country and, although it might be possible to give supply in the thickly populated districts at cheaper rates than were at present obtainable, such a course was not desirable as it was the revenue from these districts that enabled service to be given in the country areas. As far as profits from the sale of energy were concerned he thought the best plan was to give them back to the consumers in the way of reduced charges.

Mr. Coates reviewed the progress of electrical development in the Dominion. Since 1921, transmission and distribution lines had increased by 394 per cent, and installed generator capacity had risen from 49,000 kw. to 90,000 kw. The capital expenditure on electric supply was £3,600,000 in 1921 and £7,800,000 in 1925.

Amongst the various remits submitted to the conference was one asking that the government make a reduction in its standard charge of £2/10/- per quarter for the first 200 kv.a. of bulk supply. Another requested the government to decrease the duty on electrical appliances. Several remits were passed advocating the simplification of the statistical and other returns required by the public works department. An important motion carried by the conference voiced the opinion that the time had arrived for serious consideration of the electrical branch of the public works department as to whether it should be carried on as a separate entity. It was pointed out that the activities and responsibility of the department had greatly increased, and that its electrical works were of sufficient importance to warrant separate administration.

LICENSING OF WIREMEN IN NEW ZEALAND

A bill has been introduced into the New Zealand parliament making complete provision for the licensing and registration of all electric wiremen. A board of control is to be set up comprising one representative each from the power boards as a whole, the insurance companies, the electrical traders and the licensed wiremen. The chief electrical engineer of the public works department will act ex officio as chairman.

The functions of the board will consist of providing for examination of applicants for licenses, maintenance of a register of qualified wiremen, examination of complaints, and where necessary, endorsement of existing licenses. Licensed wiremen will have the right to appeal to the minister for works in all cases where the endorsement of licenses is concerned. Special appeal boards will in normal cases consist of a magistrate and two assessors, and offences against the Act are punishable by fines not exceeding £20.

The Power Boards' Association, which recently met in Wellington, has submitted draft regulations for the licensing of wiremen. After April, 1926, no electric wiring may be done in New Zealand except under the direct supervision of a duly licensed electric wireman.

ENGINEERING STANDARDS ASSOCIATION'S REPORT

The first general report of the Australian Commonwealth Engineering Standards Association, covering the period ended June 30, 1924, has been issued. It reviews briefly the events leading up to the formation of the Association and gives details of the organisation and personnel of the various committees. The affairs of the Association are managed by a main committee which decides in which direction standardisation work shall be undertaken, and generally coordinates the work of the sectional committees. In addition to the main committee there are various standing and organisation committees which deal with different phases of the Association's activities. The sectional committees handle the various subjects in which standardisation is being undertaken. Amongst these subjects may be mentioned electrical standardisation, power survey, structural steel, and cement. Further division is made into sub-committees which handle the detail work. Particulars of the organisation are shown in a chart attached to the report.

Membership of the Association is open to individuals, organisations, companies or firms on payment of an annual subscription of not less

than £2/2/-. The Association is not a commercial undertaking, but the movement is a voluntary effort to introduce the principles of standardisation to the best advantage of all concerned. The members of the various committees give their services gratuitously, and the only expenses are those incurred in management, administration and certain travelling expenses. The Association's sources of income are membership fees, grants from the federal and state governments and voluntary contributions from industry.

Accompanying the report is a progress sheet showing the stage arrived at in the various investigations at the end of the first half year of 1925. At that time two tentative specifications had been issued and 24 had been approved for issue, while a great number of subjects were under consideration.

NATIONAL ELECTRIC LIGHT ASSOCIATION, U.S.A.

The annual convention of the National Electric Light Association is the outstanding event of the year to the electric supply industry in the United States of America. It is the electrical parliament, where representatives of electric supply undertakings in all parts of the country meet to discuss their problems, help each other along the road of progress and formulate policies for future service. Such a meeting, with the delegates approaching matters in the right spirit cannot fail to result in great benefit to the community in general. The meetings were held this year during the month of June, in San Francisco. The place was appropriate for a progressive association, for in one branch of electrical work, viz., hydroelectric development, Californian undertakings lead the world.

The convention dealt with a very wide range of subjects, all the way from the question of government ownership of public utilities to domestic and farming applications of electrical energy. Addresses were given by experts in the various branches, and the interchange of ideas alone, apart from the formulation of any concerted policies, should bring about great benefits to supply undertakings and consumers alike. In addition, reports were received from numerous active committees dealing with various phases of the electric supply industry. The general effect of the convention should be to give a great impetus to electrical development throughout the United States.

A deputation from the Power Boards' Association to the prime minister of New Zealand suggested recently that the government take steps to provide for the registration of electrical engineers.

STREET CARS TO SUIT THE PUBLIC DEMAND

Experiments are being carried out by the Grand Rapids Railway Co., U.S.A., with a view to discovering the type of street car most popular among passengers. Three cars have been supplied, each by a different builder, incorporating features making for the maximum of comfort and convenience. These vehicles are being operated in ordinary service and comparative records of operating data are being kept. The manager of the undertaking recognises that it is the point of view of the public that should count in giving street car service, therefore he is endeavoring to discover what the public really wants. When this is ascertained, every effort will be made to supply the popular demand and thus gain the sympathy and hold the custom of the car riders.

Amongst the devices incorporated in these cars in the endeavor to arrive at a maximum of riding convenience are roller bearing trucks, cushion wheels, automatic treadle exit doors, non-rattling window frames, low floors and low steps, band type brakes, underslung semi-elliptic springs, and such internal fittings as special lighting arrangements and a loud speaker for announcing streets. Coupled with these features the cars are all designed with a view to obtaining the best possible running economy.

HYDROELECTRIC POWER FOR IRELAND

Messrs. Siemens Schuckert, of Germany, have contracted with the government of the Irish Free State to establish a hydroelectric scheme developing power from the river Shannon. Four generating stations, with an aggregate of 90,000 installed h.p., are to be laid down, and power is to be distributed to all parts of the country. The preliminary portion of the scheme involves a cost of £2,500,000, and it is estimated that the total cost will be £5,200,000.

OPEN BALLASTED TRAM TRACKS

The Melbourne tramways board, in carrying out the conversion of the tram lines in St. Kilda from cable to electric traction, is seeking authority to form a reserve down the centre of Fitzroy street and to construct an open ballasted permanent way in the reserve. This type of track is already in use in Dandenong road and on the line running through Royal Park.

Correspondence

How Can a Country Town Augment the Day Load?

To the Editor,

Sir,—In the *Electrical Engineer* for August, I notice a report of a Victorian shire wishing to install a refrigerating plant. Perhaps a few facts regarding a similar situation would be of interest.

Some time ago I recommended my council to reduce the tariff to 1½d. per unit for cooking purposes only. But although I have advertised the benefit to consumers under that rate for a period of about two years, I have not been able to get anyone to take advantage of it. Being mostly working men the price of electric stoves is too high, and as I am not financial enough myself to purchase a few stoves and let them out on hire, and the council is also debarred from entering into trading, you can quite understand that the position is difficult. The next best thing, to my mind, was to use the available power to our own advantage, therefore, I advocated the establishment of an ice-making plant. No ice is made locally, all requirements coming by rail from a town 60 miles away. Taking the present consumption and comparing it with the cost of a machine, a clear profit of 30 per cent could be made from the sale of ice. The idea was not competition with anyone. I have made it known that any large consumer of current will get good concessions but still we only have small motors installed here.

Our prices for current are: lighting 11d., power 6d., special cooking 1½d. We have recently installed a 43 b.h.p. Crossley crude oil engine, direct coupled to a 25 kw. generator. This is an unattended set and it will run on all loads up to 110 amps. During the day, however, 40 amps is a big load, so you can understand that we have a great deal of surplus energy. Should we be able to install any by-product machine it will naturally cause reductions in the power and lighting tariffs. I think country power houses generally are like ourselves: they have a good night load and no day load. Should any of your readers be able to suggest a way to utilise the surplus energy it would be appreciated.

Yours, etc.,

Country Town Engineer.

August 24, 1925.

Radio News

Mr. O. F. Mingay, manager of the Burgin Electric Co., Sydney, is shortly leaving for England to make a study of radio conditions.

The Royal Prince Alfred Hospital, Sydney, is to install radio equipment for the individual use of every patient. Headphones are to be provided for the full complement of 520.

Through the generosity of the Essendon radio club a four-valve receiving set has been installed at the Green Vale sanatorium, near Melbourne.

Mr. D. Robertson, chairman of the British Radio Telegraphists' Association, arrived in Sydney on August 27. He is first wireless operator on the R.M.S. Mongolia.

Successful re-broadcasting of a musical programme from station 3LO, Melbourne, was recently carried out by station 2FC, Sydney. Both stations operate on a power of five kw., the respective wave lengths being 371 and 1,100 metres.

A site has been selected at Skegness, England, for the erection of the beam wireless receiving plant for communication with Australia. The transmitter is to be erected at Grimsby. Both plants are to be in operation by May, 1926. The Australian stations are to be complete in January.

Marconi's Wireless Telegraph Co., which is engaged in important undertakings in Australia, has issued its accounts for the year 1924. Gross profit for the year was £624,193, and net profit £225,600. Dividend on the ordinary shares, which is at the previous rate of 10 per cent per annum, absorbs £300,006, and after providing for the preference dividend the balance carried forward is £310,652, as against £402,558 brought in. The balance sheet shows issued capital at £3,000,065.

Two attractive catalogues of radio sets, equipment and components have come to hand from the Sterling Telephone and Electric Co. Ltd., London. The company has been manufacturing telephones for more than 20 years and consequently has experience to draw upon in designing and building sound-producing equipment for radio use. Headphones are made by the company in several patterns, as also are loud speakers, the latter line including the Primax hornless type. The company manufactures all classes of radio components and accessories and also several types of complete receiving set. The workmanship throughout is of the first quality and the material is of proven reliability.

Mr. Spencer Nolan, junr., of Sydney, has been in two-way communication with the Macmillan polar expedition at Etah, Greenland. The communication officer with the polar expedition is Mr. John L. Reinartz, who is acknowledged as the leading American amateur. The transmitter with which he communicated with Australia is a 250 watt c.w. and telephone set built for operation between 10 and 180 metres. The wave lengths usually employed are 20 and 35 metres, and it was on the latter that the work with Australia was done.

SIMULTANEOUS BROADCASTING

In connection with the publicity campaign for the Commonwealth war conversion loan an address by the secretary of the federal treasury was recently broadcasted simultaneously from six stations in four states of the Commonwealth. The speaker was located at the central telephone exchange, Melbourne. His voice was carried over land lines to the two Melbourne broadcasting stations, 3LO and 3AR, and via the postal department's trunk telephone lines to the Adelaide station, 5CL, the two Sydney stations, 2FC and 2BL, and the Brisbane station, 4QG. The broadcasting was very successful and it is estimated that the speech was heard by 200,000 people.

THE RUGBY RADIO STATION, ENGLAND

Rapid progress is being made with the construction of the government radio telegraph and telephone station near Rugby, England. The installation is designed with a view to direct communication with the British dominions, and it is hoped that the work will be complete by the end of the year.

Included in the plant are three 500 kw. motor generator sets for furnishing high pressure supply, at 12,000 to 18,000 volts, to the valves. Each set consists of two 6,000 volt d.c. generators, connected in series, driven by a synchronous motor. The bedplates of the machines are mounted on insulators. The filament supply will be provided by a 200 kv.a. 416 volt, 100 cycle synchronous motor alternator set. There will be 54 metal-glass valves connected in parallel for transmitting. Cooling water for these will be provided from a 500,000 gallon concrete reservoir.

The aerial will be supported by 12 lattice steel masts each 820 ft. high. Each mast stands on a porcelain insulator and a granite block capable of taking the downward thrust of 400 tons. The aerial will take the form of wire sausages spaced by means of 12 ft. diameter steel spreaders, and will be $2\frac{3}{4}$ miles in length. The earth system consists of about 80 miles of wire laid just beneath the surface of the ground. (Electrical Review.)

NEW ZEALAND BROADCASTING AGREEMENT

The agreement recently arrived at between the government of New Zealand and the trustees of the new broadcasting company with respect to the establishment of a satisfactory broadcasting service in the Dominion was referred to in the last number of the *Electrical Engineer*. Under the broadcasting regulations the post and telegraph department will collect an annual license fee of 30/- from each listener-in. Of this amount 25/- will be credited to a broadcasting fund which will also benefit to the extent of 90 per cent of the fees received in respect of radio dealers' licenses. The proceeds of this fund will be paid to the broadcasting company for the maintenance of efficient service, and this will be the sole source of the company's revenue. The company is allowed to pay to shareholders dividends not exceeding $7\frac{1}{2}$ per cent per annum. The first of the new broadcasting stations is expected to be in operation in about six months' time. In the meantime it is hoped that the existing broadcasting services will continue operations. The government is at present paying a subsidy out of listeners' fees at the rate of £15 per week to each of these stations.

Provision has been made that the new company shall indemnify the government against all actions, claims, and demands which may be brought or made by any person in respect of injury arising from any act of the company or its agents. This indemnity does not, however, extend to claims which may be made upon the government in respect of patents. In the matter of patents, the act provides that any person or company who or which may be a party to an agreement with the minister of telegraphs in respect of broadcasting service shall be deemed for the purpose of the Patents, Designs and Trade Marks Act to be the agent or the post and telegraph department during the currency of the agreement.

WAVE LENGTH OR FREQUENCY

It has always been somewhat puzzling to the average electrical engineer, accustomed to alternating current phenomena, that the term wave length should be used instead of frequency in radio work. The propagation of electro-magnetic waves is essentially an electrical phenomenon, and it is difficult to see anything reasonable in referring to the pulsation of the currents producing or produced by those waves in different terms to the pulsation of ordinary power currents. The application is certainly different but the currents are the same and obey the

same laws, though in different degree. For purposes of calculation the wave length terminology is very clumsy and indeed is somewhat misleading. For instance, the possibility of interference between two transmitting stations cannot be judged directly from their wave lengths, for the longer the wave length the greater must be the separation in metres. With the frequency designation, however, the necessary degree of separation, measured in cycles, is the same right along the scale.

The wave length system evidently originated in imitation of light measurements, and the only point in favor of it now seems to be that most people are accustomed to it. The recent development of short wave working, however, has emphasised its shortcomings. It should not be difficult to make a change on to the frequency terminology. Engineers will take to it naturally, and amateur operators who have had to get used to the wave length system can just as easily accustom themselves to the frequency designation. The frequencies in use for radio communication are, of course, very high, and it will therefore probably be found convenient to use the kilocycle as a unit. Strong efforts are being made in America to change on to the more logical unit, but it is desirable that all countries should fall into line in order to avoid confusion.

AMATEUR RADIO RELAYING TO BE INAUGURATED

A scheme for the commencement at an early date of amateur wireless relay work in Australia along the lines of the American Radio Relay League has been approved by the Wireless Institute of Australia. A traffic branch is being organised and work will be controlled by the headquarters council, Sydney. A 50 watt transmitting station (2 WI) is to be installed in Sydney, by means of which headquarters will be in touch with all state branches of the institute throughout Australia. The Sydney division will be in direct communication with Melbourne and Brisbane, whilst Melbourne will relay to Adelaide and Adelaide to Perth. The state headquarters will control communications with various organisations and clubs throughout the division.

Hitherto restrictions under the posts and telegraphs act have prevented work of this nature being carried out, but an agreement has been arrived at between the representatives of the postmaster general and the Wireless Institute, so that the innovation will be under strict control and supervision.

Telephony and Telegraphy

COMMONWEALTH P.M.G.'s DEPARTMENT

Operations During August

New South Wales.—Fourteen trunk lines have been completed, and ten country public lines erected. New exchanges have been opened at nine centres, and additional equipment installed at 11 exchanges.

Victoria.—Twelve trunk lines have been completed, and nine country public lines erected. New exchanges have been opened at 13 centres and additional equipment installed at 24 exchanges.

Queensland.—Eight country public lines were erected, and additional equipment installed at five exchanges.

South Australia.—One country public line was erected, and additional equipment installed at 13 exchanges. Relay repeaters were installed at Alice Springs on the Adelaide-Darwin telegraph line.

Western Australia.—Seven trunk lines have been completed, and two country public lines erected. New exchanges have been opened at six centres, and additional equipment installed at 16 exchanges.

Tasmania.—Two trunk lines have been completed, and two country public lines erected. Additional equipment has been installed at two exchanges.

CARRIER WAVE TELEPHONE SERVICE BETWEEN SYDNEY AND MELBOURNE

During the last twelve months the postmaster-general's department has been engaged on a large programme of reconstruction work with a view to improving the telephone communication between Sydney and Melbourne. In addition to the reconstruction of the route, over a distance of nearly 600 miles, an installation of the carrier wave system has been provided. Up to the present time there have been but two communication circuits between the cities. Under the new arrangements, which have just been put in operation, one of these circuits has been made the channel through which four telephone conversations can be carried on simultaneously. In addition the circuit will accommodate two duplex telegraph circuits on which four telegrams may be transmitted simultaneously.

The carrier wave system uses high frequency electrical waves which are propagated along the line after modulation by the speech from the

telephone user. A wave of different frequency is propagated in respect of each speech channel and the resultant complex wave is split up into the correct channels at the receiving end of the circuit by means of filter apparatus which discriminates between the frequencies. The actual frequencies being utilised in the Melbourne-Sydney service are given in the table.

Channel	Transmission from Sydney to Melbourne	Transmission from Melbourne to Sydney
No. 1 -- --	6 kilo cycles	15 kilo cycles
No. 2 -- --	9 " "	18 " "
No. 3 -- --	12 " "	21 " "

The velocity of propagation of the electrical waves over the telephone circuit is rather less than the propagation of wireless waves in the ether, which is at the rate of approximately 186,000 miles per second. The velocity of propagation over the Sydney-Melbourne circuit is in the neighborhood of 175,000 miles per second.

The communication route is equipped with three repeating stations, at Wangaratta, Wagga and Goulburn respectively. The repeaters amplify the energy reaching them from distant stations, so as to counteract the attenuation of the line. In practice each repeater boosts the power to approximately its original value and passes it on to the next repeater. At the receiving terminal stations the carrier wave is eliminated and a replica of the electrical impulses emanating from the transmitting subscriber's voice is passed forward via the ordinary telephone network to the receiving subscriber. The circuit under discussion uses three carrier wave and one ordinary speech channel. So successful is the system that no difference can be detected in the speech quality by the different channels. The apparatus used was supplied by the Western Electric Co., of America, and installed by members of the staff of the postmaster-general's department under the supervision of the company's engineer. This is the first installation of the system to be made outside America.

New Publication

Electrical Wiring Rules of the Institution of Engineers, Australia, 56 pages. Posted 7d. These rules, revised to June, 1925, are based upon the code in use for many years throughout Australia, which was originally founded upon the wiring rules of the Institution of Electrical Engineers, London. Since 1922 a number of conferences have been held of the uniform wiring rules committee of the institution, resulting in their general adoption throughout Australia.

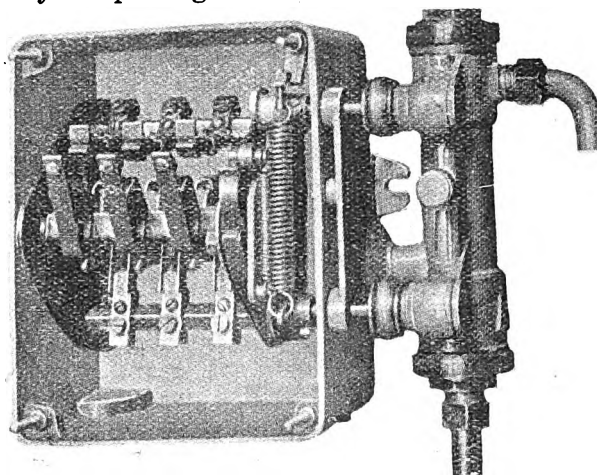
Trade Notes

Condor Lamps (Australasia) Ltd. has been registered with £25,000 authorised capital to carry on business as electricians and electric apparatus manufacturers. The first directors are: A. B. Scott, G. L. Murray, J. A. L. Brown-wers, T. J. V. Lohnizen, J. E. H. Rieter. The office is at Sydney.

G.E.C. Annual Report.—The report of the directors of the General Electric Co. Ltd., London, for the year ended Mar. 31, 1925, shows a definite improvement in the company's business. The trading profit for the year was £1,029,980, being £194,420 more than that for the previous year. After making provision for interest, depreciation, etc., and paying dividends totalling £410,400, an amount of £214,250 was carried forward, £212,450 having been brought in. The Australian and South African branches have shown an improvement in business.

Flame Proof Oil Circuit Breaker.—Messrs. A. Reyrolle and Co. Ltd., of Hebburn, England, are well known as manufacturers of high class switchgear. Amongst the numerous applications of equipment with which they deal is the control of electricity in mines and places where the most rigid care is necessary against the propagation of combustion. A typical example of equipment for such use is the flame proof circuit breaker. A switch of this type for a normal rating of 60 amps at 660 volts three phase is very massive in construction. The movable contacts are made of hard copper and are protected by auxiliary renewable contacts. They are mounted upon a solid hinged arm directly connected to a toggle link motion operated by the switch handle. The stationary contacts are of solid brass mounted on porcelain insulators cemented into the frame casting. The tank and cover are separate items, each constructed of a strong, ribbed iron casting, and they are jointed by nine screws on a wide machined face. The cables are led to the terminals through glands with hemp packing. The enclosure formed when the tank is screwed to the cover has successfully withstood a hydraulic pressure test at 100 lb. per sq. in. A special test applied to the apparatus consisted of filling the casing with the most explosive mixture of firedamp and air, surrounding the apparatus with a similar mixture and igniting the mixture in the casing by means of a secondary discharge from an induction coil. Under these conditions no flame passed from the apparatus to the explosive atmosphere outside, which remained unignited, nor did the apparatus suffer damage due to the pressure developed within it.

Hydraulically Operated Switchgear.—The Henkerbak Syndicate Ltd., The Hague, Holland, have forwarded particulars of their new automatically operated switchgear for the control of water heating circuits. The function of the switch is to cut off current from the heating device if the flow of the liquid being heated falls below a pre-determined quantity. The switch is operated by a piston through a system of levers. When the flow of water is started, as by a tap being turned on in a house hot water



Henkerbak Automatic Switch

system, the piston rises and causes the switch to close. The cessation of the flow allows the piston to be drawn down again by the tension of a spring, and the switch opens the circuit. The switches are of the quick make and break type, and the device is made in several sizes for different applications. The illustration shows a 500-volt 60-amp switch. A smaller size is made for direct attachment to a 6-kw. water heater.

English Electric Co. of Australia Ltd.—During the year ended March 31 last, the English Electric Co. of Australia Ltd. realised a net profit of £22,047. This included an award of £16,446 in a claim against the Sydney city council. An amount of £18,032 was brought in, and it is proposed to pay a five per cent dividend, absorbing £18,491, and to carry forward £22,588. The annual report states that there is no doubt about the company's ability to manufacture in Australia electrical machinery up to the largest sizes required. The New South Wales railway commissioners have ordered two 25,000 h.p. turbo-alternator sets from the company, one of which is now ready for steam in the White Bay power house. The turbines are built to the designs of Messrs. C. A. Parsons and Co. Ltd., England, and the whole of the plant has been fabricated in Australia. The units include castings up to 30 tons weight, and the condensers are believed to be the largest manufactured in the British Empire.

New Westinghouse Catalogue.—The Westinghouse Electric and Manufacturing Co., U.S.A., is distributing its new 1925-27 catalogue of electrical supplies. The publication, which contains 1,200 pages and is illustrated with 4,500 engravings, lists all new apparatus designed and manufactured in the past two years, as well as all the previous established types. Brief descriptions of the company's industrial motors and controllers, power and marine equipment, large switchboards and oil circuit breakers, and railway supplies are also included.

Electrical Recording Instruments.—The high quality of the electrical instruments manufactured by Messrs. Evershed and Vignoles Ltd., London, is well known. Amongst the many lines the recorders for various applications are especially noteworthy. These are made in three distinct designs, differing from one another in the type of chart used. The charts may be either of the roll or continuous type, the drum or single revolution type, or the disc or circular type. For the first two the Murday system is used, employing charts with rectilinear coordinates. The circular charts are operated on the Binstead system, and trace to polar coordinates. The same case is used for all instruments of the roll or drum type, whether ammeters, voltmeters, wattmeters or leakage recorders. For the disc type a somewhat deeper case is required. The charts are driven by clock mechanism of high grade construction and excellent reliability. The clock and chart are mounted in the lower part of the case, and the electrical movement carrying the record tracing device is in the upper part. For the ammeter and voltmeter movements the moving coil and moving iron systems are used for d.c. and a.c. respectively. For the wattmeters the dynamometer movement with two fixed coils and one moving coil is used. The recording pen may be either of the trough type or, in applications where large quantities of ink are required, of the syphon type with an ink reservoir.

An instrument of special interest is the leakage recorder, which is designed to operate on d.c. two wire circuits for the purpose of recording the state of the insulation on the mains and the value of leakage current which may be flowing. The instrument has three terminals connected respectively to the positive main, the negative main and the earth. The chart is of the central zero type. The electrical movement is arranged with automatic switching that changes over between positive on and negative off, both circuits on, and negative on positive off in cycles of a quarter of an hour. This instrument is very valuable for keeping a check on the condition of the mains. If desired a relay can be provided which rings a bell to call the attention of the operator when a leak occurs.

Further particulars of these instruments are obtainable from the Australian agents, Messrs. H. Rowe and Co.

Commutating Rectifiers.—The Lancashire Dynamo and Motor Co. Ltd., in association with the Crypto Electrical Co. Ltd., London, is producing a line of commutating rectifiers suitable for such services as battery charging, and all purposes where d.c. is used on non-inductive circuits. The machine, Fig. 1, consists of a

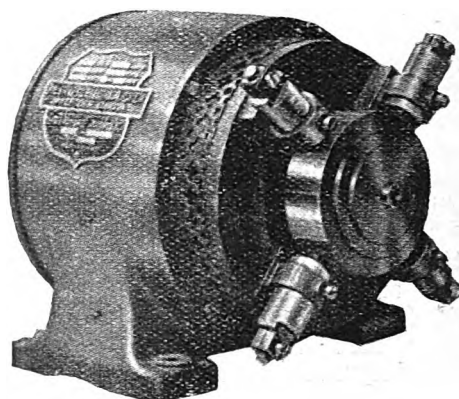


Fig. 1. Crypto Commutating Rectifier.

self-starting synchronous motor fitted with an external commutator and brushgear for rectifying the alternating current from the supply mains. The a.c. supply drives the motor and feeds also the primary winding of a specially designed static transformer. The low tension a.c. obtained from the secondary winding of the transformer is converted into unidirectional current by means of the special commutator which is mounted on, or coupled to, the motor shaft. The commutator works in conjunction with four brushes, one pair being connected to the low tension winding of the transformer and

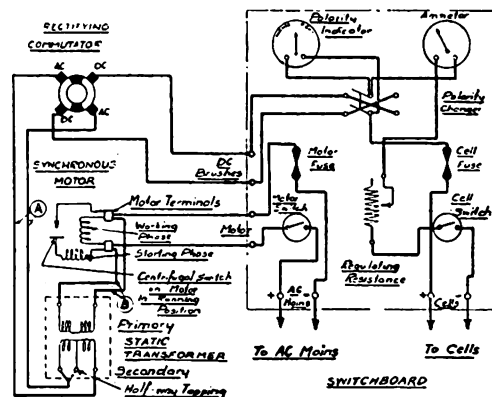


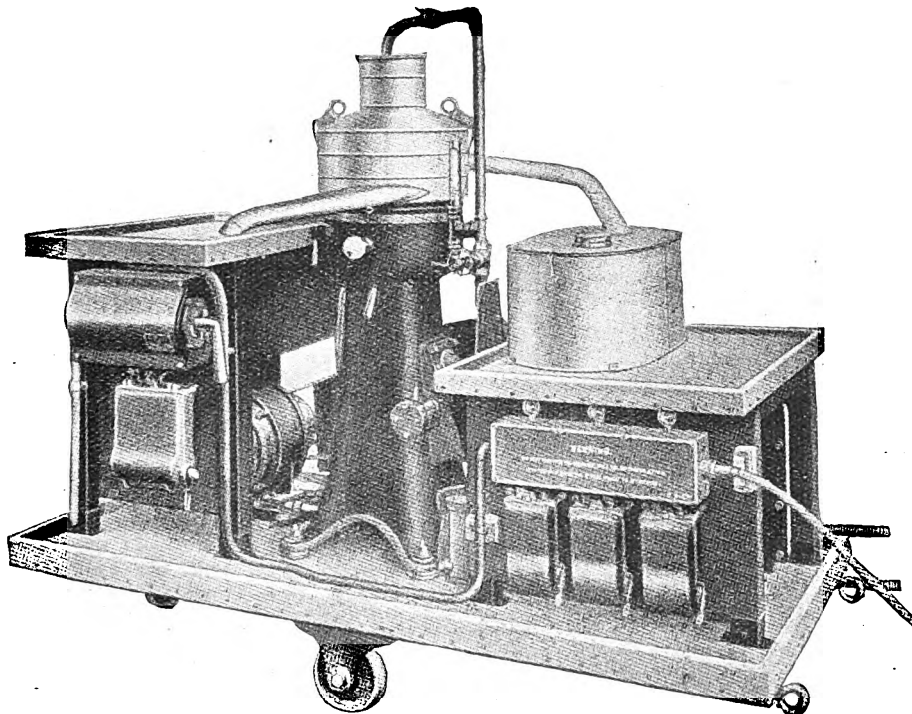
Fig. 2. Diagram of Connections of Crypto Rectifier

the d.c. being obtained from the other pair. The connections are shown diagrammatically in Fig. 2. The transformer is air-cooled. Normal d.c. voltage regulation is obtained by means of series resistance, but further means can be provided

by tappings on the transformer secondary. To start the machine it is only necessary to close the motor switch. A polarity changer and indicator is provided so that the correct polarity of d.c. may be obtained for cell charging. The rectifiers are made in several sizes for operation on single phase mains up to 500 volts. The outputs range from 5 amps at 16 volts to 70 amps at 70 volts or 15 amps at 200 volts. Efficiencies in the neighbourhood of 80 per cent are claimed for the larger sizes. Further particulars are obtainable from the agents for the Lancashire Dynamo and Motor Co., viz., Messrs. Coates and Co. Pty. Ltd., of Melbourne and Sydney; Harris, Scarfe and Sandover, Perth; Australian Implement and Furnishing Co., Adelaide; R. H. Underhill, Brisbane.

Vickcen Centrifugal Separators.—The Metropolitan-Vickers Electrical Co. Ltd. is manufacturing Vickcen centrifugal separators for the purification of lubricating, fuel or switch and transformer oils. The machines are made in standard capacities from 10 to 600 gal. per hour and can

a strong steel outside shell, which acts as the receiver for the separated solids, and a distributor. The distributor has a number of external ribs on which are carried several conical sheet steel plates. The liquid to be dealt with is fed into the separator through a gauze strainer at the top. It flows down through a central tube to the bottom of the distributor and then up through holes in the distributor and the conical plates and is spread in thin layers between the plates. The whole separating bowl revolves at a high speed and the centrifugal force acting on the thin layers of liquid separates the heavier from the lighter portions. Thus the solids are thrown against the outer shell, and the heavier portions of the liquid move nearer the circumference of the shell than the lighter portions. The cap of the bowl is conical in shape in conformity with the distributor plates, and just beneath the cap is a top plate. Annular spaces on the inside and outside of this plate permit of the lighter and heavier liquids rising into collecting traps arranged round the



Vickcen Portable Oil Separator Outfit

be supplied in several different arrangements. They may be used to separate solids from liquid, to separate liquids of different specific gravity, or to perform both these operations simultaneously. Any class of oil from heavy crude oil to light distillates may be dealt with. The machine consists in its essentials of a strong upright body, carrying a centrifugal separating bowl on a vertical shaft driven through worm gearing from a belt pulley. The bowl comprises

spindle of the machine just below the inlet strainer. Spouts are provided on these trap bowls to lead the different grades of oil to containers as required. The separating arrangements may be varied for dealing with different grades of oil and for obtaining different degrees of separation.

The machine may be supplied either with fast and loose pulleys for belt drive, or with an electric motor mounted on the body frame or on

a common bedplate driving through a belt and a centrifugal clutch. From the pulley the drive is transmitted by a worm wheel and worm to the central shaft, and thence to the bowl spindle by means of a flexible coupling. A special brake, with Ferrodo lining bearing against the outside of the bowl shell, is provided to facilitate quick stopping. With certain oils maximum efficiency of separation can only be obtained when the viscosity is reduced by heating. The necessary temperature can be obtained either by means of exhaust steam passed through a coiled pipe or by a separate Vickcen electric heater. The Vickcen outfits are supplied either for permanent installation or in a portable form. The illustration shows one of the portable type. This outfit includes the complete vertical separator, electric driving motor with starter, electric heater with sectional switches, dual oil strainer, two chain driven pumps, de-aerating tank with double baffle and float control, cleaning table with clamp for bowl, and drawer with the necessary tools.

Mica.—Mica Products Pty. Ltd., 94-98 Queen street, Melbourne, has issued a trade list of

products turned out from its works. In addition to the lines quoted the company executes special orders. As there is no reliable substitute for Mica as insulation in electrical work, it is satisfactory to know that the varied demands of the electrical industry are being met. Those interested may obtain a copy of the list on application to the company.

POSITIONS VACANT

The shire of Mansfield, Vic., has invited applications, closing September 25, for the position of engineer in charge of the council's electric supply plant. Salary is at the rate of £400 per annum, rising to £450.

The Sydney city council is inviting applications for the position of resident engineer for construction in connection with the new Bunnerong power station. The commencing salary is £800 per annum. Applications close at noon on October 19, 1925.

Lighting and Power

Albany, W.A.—The municipal council has accepted the tender of Messrs. Denny Bros. Ltd., of Perth, for the supply of additional plant for the electrical undertaking, including one 100 kw. British General Electric generator direct coupled to a Campbell four cylinder vertical crude oil engine, one 12½ kw. English Electric generator direct coupled to a Campbell single cylinder horizontal crude oil engine, and one 35 kw. English Electric generator for belt drive.

Auckland, N.Z.—The Auckland power board is to receive bulk supply from the public works department's Arapuni hydroelectric station in April, 1928. It was originally intended to take the supply at 11,000 volts but the chief engineer to the board, Mr. R. H. Bartley, now reports that it will be more economical to take it at 22,000 volts. This alteration will necessitate certain changes in layout and the payment of a small amount of compensation to the public works department in respect of expenses already incurred. The supply will be received at a substation at Penrose, and transmitted by underground cable a distance of seven miles to the King's Wharf station. The estimated loading in the board's area will be 33,700 kw. in 1934.

Barnawatha, Vic.—The electricity commission is inquiring into the practicability of giving electric supply to the town via Chiltern.

Belgrave, Vic.—The electricity commission, which has taken over from the Belgrave and Gully Electric Supply Co., will have electric supply available in Ferntree Gully, Upwey and Belgrave by the end of October. The company's generating plant broke down some months ago, and during the progress of negotiations with the commission residents have had no supply.

Berry, N.S.W.—The municipal council has approved of the scheme for giving electric supply to Berry and Bomaderry, drawn up by Mr. H. J. Hoggan, consulting engineer. Energy is to be purchased in bulk at 6,600 volts,

and distributed at 415/240 volts, 50 cycle three phase. A capital outlay of £7,000 is involved.

Blenheim, N.Z.—The Marlborough power board has decided to use concrete poles for its transmission lines wherever such use is economically possible.

Birdwood, S.A.—The Adelaide Electric Supply Co. is now giving supply through high tension mains running via Gawler.

Brighton, Tas.—The council is taking steps towards raising a loan of £6,300 for electric supply purposes.

Caltowie, S.A.—The Adelaide Electric Supply Co. has stated its intention of proceeding immediately with the extension of its mains to the district via Halbury, Blyth, Brinkworth, Georgetown and Gladstone.

Charlton, Vic.—The Charlton Electric Light and Power Co. is installing additional generating plant at a cost of £1,500. A 35 kw. crude oil generating set is being put in.

Chiltern, Vic.—The electricity commission has signified its willingness to take over the shire council's electrical undertaking, paying off the present loan, £3,250, and changing over from d.c. to a.c. Power from Yallourn will be available in the district by March, 1925.

Cunnamulla, Q'ld.—The Paroo shire council is asking the government to guarantee a loan of £6,500 for an electric supply installation. The money will be obtained from the A.M.P. Society.

Dalwallinu, W.A.—Extensions are to be made to the town lighting scheme. The undertaking is in the hands of Mr. L. Perry.

Devonport, N.Z.—The council has agreed to the terms and conditions offered by the Waitemata power board for the purchase of the borough electric supply undertaking.

Edinburgh, S.A.—The municipal council is about to embark on an electric supply scheme.

Eketahuna, N.Z.—The Tararua power board is reducing its domestic power tariff to 2d. per unit for the first 200 units per month and 1d. per unit for all in excess.

Elmore, Vic.—The Elmore Electric Light Co. is installing a 50 h.p. crude oil generating set in lieu of the present steam plant.

Emerald, Q'ld.—The shire council is taking steps to raise a loan of £20,000 for electric supply purposes.

Gatton, Q'ld.—Enquiries are being made with a view to inaugurating an electric supply scheme.

Gisborne, N.Z.—The borough council is taking steps towards raising a loan of £20,000 for electrical extensions.

Gumeracha, S.A.—Electric supply is now available from the mains of the Adelaide Electric Supply Co. The transmission lines run from the Osborne power station via Gawler.

Ingleburn, N.S.W.—The municipal council has instructed Mr. H. J. Hoggan, consulting engineer, Sydney to report on the establishment of an electricity undertaking to supply Glenfield, Macquarie Fields and Mintaro railway station. Current will be purchased in bulk at 11,000 volts and supplied at 415/240 volts, 50 cycles, three phase.

Jamestown, S.A.—A proposal that the council's electric supply reticulation system be sold to the Adelaide Electric Supply Co. has been rejected at a poll of ratepayers. The supply undertaking has not been paying, but the electrical engineer, Mr. J. B. Manuel, has submitted a scheme for enlargement and reconstruction of the plant and mains which he considers will bring about an improvement in the finances.

Kerang, Vic.—The shire council is calling tenders for a 120 h.p. and a 60 h.p. crude oil generating set, each to generate at 240 volts d.c.

Lismore, N.S.W.—The council is raising a loan of £25,000 for reconstruction of and additions to the electric supply plant.

Liverpool, N.S.W.—The council's electric supply undertaking will be officially opened on September 26. Energy is purchased in bulk at 11,000 volts from the railway commissioners, and distributed at 415/240 volts, 50 cycle, three phase. The prices for lighting and power will be 7d. and 4d. per unit respectively. Mr. H. J. Hoggan, of Sydney, is the consulting engineer.

Manilla, N.S.W.—The municipal council has notified the Australian Electric Supply Co. Ltd. that it is dissatisfied with the electrical service. The council considers that a reduction in prices should be made.

Mullumbimby, N.S.W.—The new hydroelectric undertaking is to be put into operation during October.

Nelson, N.Z.—Consideration is being given to the installation of additional generating plant at the city council's electric supply station.

Onehunga, N.Z.—The electric street lighting installation has been put into operation.

Opunake, N.Z.—The Opunake power board is raising a loan of £22,000 for electrical extensions.

Orange, N.S.W.—The municipal council inaugurated its electric supply undertaking in November, 1923. The plant consists of two 7,100 lb. per hour boilers and two 250 kw. steam alternator sets. Statistics for the first complete year of operation show the number of consumers to be 621 and the connected load 693 kw. The units generated during the year totalled 566,395. The units sold were as follow: Street lighting 117,802, domestic supply 65,952, industrial lighting 99,362, industrial heating 22,862, industrial power 19,657. The generating cost was 2.05d. per unit. Mr. A. M. Conway is electrical engineer.

Otahuhu, N.Z.—The street lighting system is to be changed over from gas to electricity.

Parramatta, N.S.W.—The state government has disallowed the agreement for a franchise granted by the municipal council to the Parramatta Electric Supply Co. A 30-year franchise was to be provided, with lighting rate at 7d. per unit and power at 3d. The company purchases energy in bulk from the railway commissioners. It is alleged that the company's charges are unreasonable in view of the rate at which it receives bulk supply.

Patea, N.Z.—The council is taking steps towards raising a loan of £3,000 for extensions to the electric supply plant.

Pinnaroo, S.A.—The district council is about to undertake electricity supply. Energy will be purchased in bulk from the S.A. Farmers' Union flour mill.

Port Noarlunga, S.A.—The accounts of the Port Noarlunga Electric Supply Co. show a credit balance of £30 on the first year's operations.

Pukekohe, N.Z.—The Pukekohe substation of the Franklin power board is almost complete. When the plant is ready bulk supply will be taken from Horahora. The present power station, which was operated by the borough council, will be maintained as a standby plant.

Quirading, W.A.—The road board is having an electric light plant installed for serving its offices, and for street lighting.

Richmond, Tas.—The council is considering the inauguration of an electric supply scheme in conjunction with the Sorell and Clarence councils.

Rutherglen, Vic.—The electricity commission proposes to take over the shire council's electric supply undertaking early in 1926.

Sale, Vic.—An agreement has been reached regarding the price at which the electricity commission is to supply energy to the council for street lighting.

Tenterfield, N.S.W.—The municipal council proposes to expend £1,000 in improving the electric supply. Particulars are to be obtained of a crude oil set to run unattended after midnight.

Tolaga Bay, N.Z.—The electric supply undertaking, which is in the hands of the Uawa county council, is now in operation.

Tumut, N.S.W.—The government has refused to sanction the formation of a county council in the Tumut district for the purpose of controlling the development of hydroelectric power at Buddong Falls. The scheme which the local bodies have had in view is already included in the Burrinjuck development on which the public works department has embarked.

Walleroo, S.A.—The town council's electric supply undertaking has not been paying. Energy is purchased in bulk from the Wallaroo Mt. Lyell Fertiliser Co. The council recently incurred heavy expenditure in changing over from taking bulk supply from the Wallaroo Mining and Smelting Co., which ceased operations. Proposals have been put forward for striking a rate to cover street lighting service, and for offering special inducements to users of power.

Wanganui, N.Z.—The Wanganui-Rangitikei power board has reduced its lighting tariff to 7d. per unit for the first 100 units per month, 6d. for the next 100, and 5d. for all in excess.

Wangaratta, Vic.—The electricity commission is discussing with the council the question of taking over the electric supply undertaking. At present the council purchases energy in bulk from the Wangaratta Woollen Mills Co.

Wasleys, S.A.—Electric supply has been made available from the mains of the Adelaide Electric Supply Co. Energy is brought by transmission lines from the Osborne power station via Gawler.

Current Prices for Electrical Supplies

The quotations in this list represent the average retail selling prices ruling in Melbourne during the month of publication. These prices are subject to bona fide traders' discounts. Special rates are obtainable in most cases for large quantities. In general Sydney prices are slightly lower.

Adaptors—				Conduit Fittings—			
Hardwood	doz.	12/6				$\frac{1}{2}$ in.	$\frac{3}{4}$ in.
Parallel	each	6/6				$\frac{1}{2}$ in.	$\frac{3}{4}$ in.
Blocks—				Grip—Tees	doz.	3/6	3/6
3 in. round	gross	22/6		" Elbows	doz.	2/9	2/9
3½ in. round	gross	25/		" Couplings	doz.	2/3	2/3
6 in. x 3 in. rectangular	doz.	6/3		Crampets	gross	5/5	5/5
9 in. x 3 in. rectangular	doz.	7/6		Conduit Fittings—			
6 in. x 6 in. square	doz.	12/6		Saddles	gross	5/	5/
Bushes—						$\frac{1}{2}$ & $\frac{3}{4}$ in.	$\frac{1}{2}$ in.
½ in. ideal metal	gross	7/6		Screwed tees	doz.	5/5	7/6
¾ in. ideal metal	gross	7/6		" elbows	doz.	3/9	5/5
1 in. ideal metal	gross	8/9		" couplings	doz.	2/9	4/
¾ in. plain wooden	doz.	1/6		" bell mouths	doz.	5/	5/
Bushes—				" " " 1 in.	doz.	14/10	
¾ in. plain wooden	doz.	1/8		" " " 1½ in.	doz.	19/6	
1 in. plain wooden	doz.	2/		" " " 1½ in.	doz.	27/	
Bells and Bell Material—				Junction Boxes—			
Bell transformers	each	12/6				$\frac{1}{2}$ in. & $\frac{3}{4}$ in.	$\frac{1}{2}$ in.
1½ volt dry cells	each	3/		2-way	doz.	10/10	10/10
Bells and Bell Material—				3-way	doz.	11/3	11/3
Bell wire—1/029 d.c.c.	1,000 yd.	32/6		4-way	doz.	11/3	11/3
1/036 d.c.c.	1,000 yd.	42/6		Fuses (Cut-outs)—			
1/029 d.c.c. and i.r.	1,000 yd.	50/				British	Japan
1/036 d.c.c. and i.r.	1,000 yd.	60/		5 amp, anchor type	doz.	10/	5/
No. 2 porous pots	each	2/1		5 amp, round chamber	doz.	17/6	8/9
No. 2 jars	doz.	8/9		8 amp, round chamber	doz.	20/	12/6
Bells and Bell Material—				10 amp, oblong	doz.	35/	25/
No. 2 zincs	each	1/3		20 amp, oblong	each	—	3/
Salammoniac	lb.	1/3		Holders—			
2½ in. wood box bells	each	4/6				English	Japan
2½ in. iron box bells	each	4/6		C/G., S/C. holders	doz.	12/6	8/9
3 in. wood (church gong)	each	18/4		½ in. and ¾ in. holders	doz.	12/6	8/9
Bell presses	from each	3/9		Batten holders	doz.	13/9	10/
Pocket Lamp Batteries—				Lamps—			
Batteries, pocket lamp	each	1/10				Metal Filament, Vacuum Type	
2-cell batteries	each	2/5		25 to 250 volts, 20 to 60 watt	each	2/	
3-cell batteries	each	2/8		20 to 250 volts, 100 watt	each	5/	
Ceiling Roses—				Lamps—			
		English	Japan			Gas-filled Type	
2-plate	doz.	12/1	6/3	20 to 250 volts, 25 to 40 watt	each	2/9	
3-plate	doz.	15/	8/9			60 watt	each 3/3
Connectors—						75 watt	each 3/9
1-way, porcelain	doz.	2/6				100 watt	each 5/3
2-way, porcelain	doz.	4/				150 watt	each 7/
3-way, porcelain	doz.	5/				200 watt	each 9/
Counterweights—						300 watt	each 13/
Porcelain	each	2/6				500 watt	each 17/6
Brass	each	5/6				750 watt	each 22/6
Shot for same	lb.	6½d.				1000 watt	each 27/6
Casing and Cover—						1500 watt	each 40/
Best white pine	100 ft.	10/				Carbon Filament	
Conduit—						All voltages, 5 to 32 candle power	doz. 24/
		Plain	Screwed			All voltages, 50 candle power	doz. 42/
½ in.	100 ft.	9/2	20/	Plugs—			
¾ in.	100 ft.	10/	20/	5 amp two pin plugs	doz.	30/	
1 in.	100 ft.	15/	57/6	5 amp two pin tops	doz.	15/	
1½ in.	100 ft.	27/6	40/	Shades, Opal—			
2 in.	100 ft.	45/	60/	8 in.	doz.	11/3	
2½ in.	100 ft.	68/	85/	9 in.	doz.	17/6	
3 in.	100 ft.	—	135/	10 in.	doz.	21/3	
¾ in. oval	100 ft.	12/6	—				

Switches—			English	Switchboard Frames—		
5 amp	s.p. pol. brass	doz.	17/6	6 in. x 6 in. local make	doz.	9/6
5 "	s.p. ox. copper	doz.	19/3	6 in. x 8 in. local make	each	1/
5 "	2-way pol. brass	doz.	30/	8 in. x 8 in. local make	each	1/3
5 "	2-way ox. copper	doz.	33/	8 in. x 10 in. local make	each	1/6
10 "	s.p. pol. brass	doz.	37/6	10 in. x 10 in. local make	each	1/8
5 "	d.p. pol. brass	doz.	40/	Tape—		
10 "	d.p. pol. brass	doz.	85/	Black adhesive	lb.	2/9
5 "	s.p. ceiling switches	each	5/6	Pure rubber	lb.	10/
5 "	2-way ceiling switches	each	7/6	Wire and Cables—		
1 "	ceiling switch and rosette	each	5/6		Per 1,000 yd.	
Switches—				1/.044, 600 meg.		£7 3 4
3 amp	American tumbler	doz.	24/	1/.064, 600 meg.		10 5 0
3 "	s.p. indicating rotary	doz.	24/	3/.036, 600 meg.		11 15 0
3 "	s.p. non-indicating rotary	doz.	22/6	7/.036, 600 meg.		20 10 0
3 "	2-way rotary	doz.	56/3	7/.044, 600 meg.		26 0 0
5 "	d.p. indicating rotary	doz.	62/6	7/.064, 600 meg.		43 10 0
10 "	d.p. indicating rotary	doz.	78/	Flexibles—		
20 "	d.p. indicating rotary	doz.	150/		Per 100 yd.	
Switchboards—			English Japan	23/.0076 cotton		£2 5 0
Single circuit marble 5 amp	each	9/9	8/	40/.0076 cotton		2 16 8
Single circuit marble 10 amp.	each	17/6	16/3	70/.0076 cotton		3 11 8
Two circuit marble 5 amp	each	19/2	15/10	110/.0076 cotton		4 13 4
Two circuit marble 10 amp	each	25/	22/			

Electrical Contracts

Full information regarding contracts invited and accepted is published every week in "Tenders," a registered newspaper issued from the office of "The Electrical Engineer." Subscription, 20/- per annum.

COMMONWEALTH

P.M.G.'s Dept., N.S.W.—Accumulator plates—Tudor Accumulator Co. Ltd.; 125 positive and 150 negative accumulator plates for Sandringham exchange—Tudor Accumulator Co.

P.M.G.'s Dept., Sth. Aust.—Telephone switchboard material at the Central, Unley, Norwood, and Hyde telephone exchanges—Western Electric Co. (Aust.) Ltd.; 50 Phonopore telephones—Radio, Phonopore and Electrical Ltd.

P.M.G.'s Dept., Victoria.—Switchboards, Western Electric Co. (Aust.) Ltd.; cadmium copper wire, Thos. Bolton; dry cells, British General Electric Co. Ltd.; insulators, R. Fowler Ltd.; The Australian Glass Manufacturers Ltd.; Firebrick Insulator and Pottery Co. Pty. Ltd.; Drayton Bros.; Calyx Porcelain Co. Ltd.; insulated copper wire, Johnson and Phillips Ltd.; insulated copper wire, Enfield Cable Works (Aust.) Ltd.; insulated copper wire, W. T. Henley's Telegraph Works Co. Ltd.; telephones, Ericsson Telephone Mfg. Co.; galvanised iron and steel stranded wire, Rylands Bros. (Aust.) Ltd.; wire galvanised iron and steel stranded; H.D. copper binding wire; British Insulated and Helsby Cables Ltd.; telephonists' telephones, Ericsson Telephone Mfg. Co.; telephonists' telephones, British General Electric Co. Ltd.

Works and Railways Dept.—One dual-control main passenger electric elevator—Standard Waygood Ltd.

STATES

N.S.W. Public Works Dept.—Copper conductors, tie wire and jointing sleeves; Kiama to Nowra transmission line—William Adams and Co. Ltd.; switches and operating rods, Kiama to Nowra transmission line—Metropolitan-Vickers Electrical Co. Ltd.; lightning arresters, Kiama to Nowra transmission line, Moss Vale transmission line, Lupton Dam sub-station—Australian Westinghouse Electric Co. Ltd.; converting steam driven pumping plant to electric drive, Cowra water supply—Worthington Simpson Ltd.; oil engine, generator and switchgear, for Wombeyan caves power supply—Dalgety and Co. Ltd.; 40 b.h.p. "Marshall" vertical crude oil engine for hotel Kosciuszko—Scrutton's Ltd.; installation of electric light, East Maitland land survey office—Commonwealth Electrical Construction and Supply Co. Ltd.; motor driven circulating water pump for Port Kembla electric supply—Alfred Snashall; hydraulic conduits,

pressure pipes and accessories, Yarragobilly caves, hydroelectric development—Australian Wood Pipe Co. Ltd.; construction of "A" and "B" sections Barrenjack hydroelectric development—Gouvernet and Coleman; water turbine, alternator and switchgear—Siemens Bros. and Co. Ltd.

South Aust. Supply and Tender Board.—1 petrol-driven electric welding set—Australian General Electric Co. Ltd. 20 telephones, buzzer type—Unbehaun and Johnstone Ltd.

State Electricity Commission of Vic.—Current transformers—British General Elect. Co. Ltd.; bare hard drawn copper cable—Brit. Insulated and Helsby Cables Ltd.

Vic. Dept. of Agriculture.—Electric motors—Australian General Electric Co. Ltd.

Vic. Public Works.—Installation electric lighting and power points at High School, Horsham—Ryan and Willsmore; installation electric lighting at nurses' block, hospital for insane, Sunbury—McDonald and Co.

Victorian Railways.—Telephone equipment—Alfred Harvey Pty. Ltd.; three phase alternating current induction motor, starting apparatus, etc.—Noyes Bros. (Melb.) Pty. Ltd., item 1, Symphony Radio Elect. Co. Pty. Ltd., items 2 and 3; lightning arrestors—Australian General Electric Co. Ltd., Australian Westinghouse Elect. Co. Ltd.; battery booster charging set, starting apparatus and accessories—Allied Engineering Ltd.; hard drawn copper telephone wire, etc., item 1, copper telephone wire, tapes, binders—British Insulated and Helsby Cables Ltd.; automatic substation equipment (consisting of mercury arc rectifiers and necessary automatic switching equipment)—Gibson, Battle (Melb.) Pty. Ltd.; electrical equipment for motor and trailer cars—Australian General Electric Co. Ltd.; three phase transformer—Johnson and Phillips Ltd.; telephone cable—British Insulated and Helsby Cables Ltd.; 2,200 volt cable—The Enfield Cable Works (A'sia) Ltd.; phase shifting apparatus—Australian General Electric Co. Ltd.; three phase A.C. induction motors, etc.; pipe ventilated wound rotor motor, 82 b.h.p., complete with slide rails, automatic control apparatus fitted with ammeter and one push button station—Crompton and Co. Ltd.; motor, electric, 30 h.p., 3 phase, 400 volts, 50 cycles, slip ring, protected ventilated type, synchronous speed, 750 r.p.m., complete, with slide rails—Noyes Bros. (Melb.) Pty. Ltd.

Vic. State Coal Mine.—Bitumen insulated cable—Lawrence and Hansen Elec. Co.; 5 amp. house service meters—Measurement Ltd.; telephones, ironclad, mining—British General Electric Co.; cable, bitumen, insulated—Enfield Cable Works Ltd.

West. Aust. Govt. Tender Board.—4 12-h.p. squirrel cage a.c. motors and starters—Wm. Adams and Co. Ltd.

GENERAL

Metropolitan Water, Sewerage, and Drainage Board, Sydney.—Three 50-h.p., three 25-h.p., and two 10-h.p. a.c. motors and starters—Noyes Bros. (Sydney) Ltd.

Sydney City Council.—Gas filled lamps—Australian General Electric Co. Ltd.; high tension and low tension cables—Siemens Bros. and Co. Ltd., and Enfield Cable Works (Australasia) Ltd.

Williamstown City Council, Vic.—One 250 kv.a. transformer—Weymouths Ltd.; 250 5-amp. service meters—Measurement Ltd.

NEW ZEALAND

Auckland Electric Power Board.—Electric crane—H. Wharton Ltd.; rotary converters and balancer equipment—Cory-Wright and Salmon (English Electric Co.); Metropolitan-Vickers Electrical Co. Ltd.

Invercargill Borough Council.—Copper triple braided cable—Rudge Electrical Coy.; rubber covered cable—Lawrence and Hanson Electrical Co. Ltd.

Otago Central Electric Power Board.—Pole iron braces—Booth Macdonald Ltd.; pole steps and bolts—Andersons Ltd.; insulators—National Elec. and Eng. Coy.; bare copper wire—S. Brown Ltd.; insulated cable—Richardson McCabe and Co.; switchgear—Canterbury Eng. Co.; switchgear—Tolley and Sons; lightning arresters and choke coils—National Elec. and Eng. Co.; fuses—Turnbull and Jones Ltd.; transformers, 11,000 and 6,600 v.—A. D. Riley and Co.; meters—Metropolitan-Vickers Elec. Co.

Public Works Dept.—Coleridge, section 180—Switchgear extensions—Metropolitan-Vickers; Mangahao—200/22,000 v. insulators—National Electrical Co.; Waikato, section 117—50,000 v. transformers—Lawrence and Hanson Co.; Mangahao, section 166—two cranes—A. D. Riley and Co. Ltd. (Morris); Mangahao, section 168—cable—Enfield Cable Works; Coleridge, section 184—80-kv. insulators—Carrick, Wedderspoon; Mangahao, section 172—lightning arresters framework—Steel Construction Co.; electric lighting, government buildings, Hutt valley—J. Stewart Electrical Company.

Waitomo Power Board.—Transformers—Swedish Electric Co.; cables—Samuel Brown Ltd.; main switchgear for Hangatiki substation—Metropolitan-Vickers Elec. Co.

TENDERS OPEN

COMMONWEALTH

P.M.G.'s Dept., General.—Sept. 22—Telephone registers. Sept. 29—Protective apparatus. Oct. 13—Induction coils. Oct. 20—Jumper wire, bells, buzzers, switchboard cable. Oct. 27—Timing clocks and calculagraphs, cordless switchboards, telephone transmitters and associated parts. Nov. 10—Sulphate of copper; telephone receivers and associated parts. Nov. 17—Junction material, magneto. Dec. 1—Motor generators. Dec. 15—Junction apparatus for manual exchanges. Dec. 22—Accumulators and C.E.M.F. cell batteries.

P.M.G.'s Dept., N.S.W.—Sept. 24—Excavating machine. Nov. 6—Automatic common battery, telephone equipment, Canberra exchange.

Works and Railways Dept.—Sept. 21—Two-speed dual control electric elevator.

STATES

Irrigation and Water Supply Commission, Queensland.—Sept. 26—One 120-kw. producer gas driven generating plant, electrically driven pumps. Oct. 17—Eight transformers.

N.S.W. Public Works Dept.—Sept. 21—Telephone communication system, Barren Jack hydroelectric development; insulators for 33,000 volts, and switchgear Kiama-Nowra transmission line. Oct. 6—Switchgear, Nepean dam; transformers, Yass water supply. Nov. 30 (extended)—Metering equipment for substations; Kiama-Nowra transmission line and Barren Jack hydroelectric development.

N.S.W. Railways and Tramways.—Sept. 23—Four feed-water meters. Oct. 7—20,000 kw. turbo-alternator, 15 small single phase transformers. Oct. 21—Two-ton industrial electric elevator; three-ton and five-ton electric overhead travelling cranes. Nov. 11—Five-ton, three-motor, electric overhead travelling crane. Dec. 16—Ten 1,800-kv.a. single phase transformers. Dec. 23—Air cooler. Jan. 13, 1926—Four 3,000-kw. rotary converter units. Jan. 27—Two 500-kw. converter units.

State Electricity Commission of Vic.—Sept. 21—250-kv.a. transformers, H.T. expulsion type fuses; 6,600-volt and L.T. insulators. Oct. 5—Steel conduit and fittings. Nov. 9—6,600-volt and L.T. lead covered and armored cable; 22,000-volt, 3-core lead covered and pilot cable. Dec. 14—22,000-volt insulators.

Victorian Railways.—Oct. 7—Electric cables, two electric transporters; accumulator cells and accessories; train lighting equipment. Oct. 14—Line relays, manganese steel rails and crossover. Oct. 21—Electric cables. Nov. 25—Air brake equipment.

Victorian State Coal Mine.—Sept. 21—3-h.p. d.c. motors and 5-h.p. a.c. motor. Nov. 25—Cables, junction boxes and switch pillars.

Victorian Public Works Dept.—Oct. 1—Electric light and telephones, police barracks; five electric motors, workshop, Pentridge; electric lighting, technical school, Warrnambool.

South Australian Supply and Tender Board.—Sept. 23—125-h.p. and 50-h.p. electric motors.

GENERAL

Caledonian Collieries Ltd., N.S.W.—Sept. 22—Ward Leonard electric winding engine with switchgear, etc.

Hornsby Shire Council, N.S.W.—Sept. 23—1,250 60-c.p. and 50 400-c.p. lamps.

Melbourne City Council.—Sept. 21—Triple pole automatic time switches; house cutout boxes, porcelain saddle pieces, suspension contactors. Nov. 9—5,000-kw. turbo-alternator.

Melbourne and Metropolitan Tramways Board.—Sept. 29—Steel poles. Dec. 8—Ten two-motor equipments, air brake equipments.

Newcastle City Council, N.S.W.—Oct. 15—2,000-kw. or 1,500-kw. turbo-alternator and condensing plant, 1,660 yd. armored cable and accessories.

Preston Town Council, Vic.—One 160-h.p. synchronous motor.

Sydney City Council.—Sept. 21—Transformer oil, maximum demand indicators. Oct. 6—Fibre conduits, L.T. shackle insulators. Nov. 2—Rubber insulated cables, D.C. feeder panels, L.T. underground cables. Dec. 14—Hand L.T. switchgear and rotary converters.

The Electric Supply Co. of Bundaberg Ltd., Qld.—Balancer booster with control panel.

NEW ZEALAND

Auckland Electric Power Board.—Oct. 19—Cables and earthenware troughing.

Public Works Dept.—Sept. 29—Waikato scheme, transmission line steel towers. Oct. 13—Waikato scheme, 110,000-volt suspension insulators, suspension insulator clamps. Oct. 20—Waikato scheme, lightning arresters; crude oil engine. Nov. 3 (time extended)—Waikato scheme, 110,000-volt transformers. Nov. 24—Two neutral earthing reactors.

Waitemata Electric Power Board.—Oct. 27—Contract No. 11 transformers.





Editorial





PREFERENCE TO UNIONISTS.

Preference to unionists is the policy of labor unions and labor governments alike. This rule takes precedence over preference to returned soldiers or any other qualifications. It is simply another way of saying that in the public service, municipal government, etc., spoils go to the victors. In the near future unless the principle is challenged, or unless the labor party is put out of power, professional men will be compelled to join a union before they can obtain a position from public authorities controlled by a labor caucus. There is perhaps something to be said in favor of the claim that the unions have been responsible for obtaining the better wages and conditions ruling in most trades, but even that does not justify the adoption of methods which would preclude a man earning his livelihood unless he joins a union. Unity is strength, says an old proverb, but only when the union is of those like-minded who are prepared to work harmoniously together. To rope in members of a union simply for the sake of membership fees is not going to give strength to any movement.

These remarks are prompted by the dismissal from the service of the Sydney city council of Mr. G. H. Mason, an electrical general tester, on the ground that he failed to comply with the council's resolution of the 1st September, 1925, which reads as follows:—"That from the 1st September, 1925, all employees of the municipal council of Sydney other than the town clerk, heads of departments, and deputy heads of departments, shall belong to and be financial members of the respective union of his or her calling." Mr. Mason has been in the employ of the city council for 15 years, and by his dismissal he will forfeit long service leave, retiring allowance, etc. No charge of incapacity or inefficiency in the carrying out of his duties has been made against Mr. Mason, and it is apparent that he has been made the first victim of the resolution as a warning to others. An incident of this kind should stir up the citizens of Sydney to action, and surely someone will challenge the equity of such a resolution in the courts, especially when it is made retrospective. It may be within the law to specify preference to unionists when making new appointments, but it is very questionable whether it can be applied to those already in the service.

OLIVER HEAVISIDE

Perhaps the most outstanding point common to men of genius right down the ages has been that their efforts to illumine mankind regarding the truths of natural phenomena have been unappreciated by their contemporaries and, indeed, have often met with marked opposition. Numerous examples might be quoted of men who have labored in obscurity in unlocking further doors of knowledge, and whose theories have been laughed at by the wiseheads of their day as absurd vaporings. But, whatever may be the opposition or disbelief, truth always triumphs in the end, and those who have suffered through misunderstanding have been ultimately justified, though only too often when it was too late for them to share in the triumph of their faith.

Such a genius was Oliver Heaviside, who died at Torquay, England, in February last, at the age of 75. Much of his early work was accepted with bare tolerance, his theories being looked upon as inapplicable to practice. Some, however, believed in him, and, to the credit of the scientific world, his genius did ultimately receive recognition, and he lived long enough to see the practical adoption of many of his suggestions. Some of his theories were of a nature sufficiently revolutionary to the practice of the day as to warrant great caution in acceptance, but there is no doubt that development in some directions, particularly in telephony, was seriously retarded for many years owing to the obstinate refusal of those responsible for the design and management of communication systems to give a fair trial to Heaviside's theories. Some of the theories and the results of their application are described in the interesting article, "Ocean Telegraphy as Influenced by Oliver Heaviside," by Mr. M. C. Timms, published in this number.

As the work of Heaviside was little known and little appreciated during most of his life, so the man himself was practically unknown, except by name, outside a very small circle. This was due to his mode of life for which, of course, he alone was responsible. Heaviside was born in London on May 13, 1850, and was for a few years in the employ of the Great Northern Telegraph Co., at Newcastle-on-Tyne. His education was not along the conventional lines considered necessary to the development of a great mathematician, and this is partly the reason that he did not attract the attention of his contemporaries. At the early age of 24, after a short

time spent in London, he retired to Torquay where practically all his subsequent work was done. He lived the life almost of a hermit, in a state of considerable poverty, seeing few people, but corresponding with one or two with whom he had ideas in common, notably, Sir Oliver Lodge, and Dr. G. F. C. Searle, of Cambridge University. He was elected a Fellow of the Royal Society in 1891, was elected an honorary member of the Institution of Electrical Engineers in 1908 and became the first Faraday medallist of that institution in 1922. In addition, in the latter years of his life, he received the recognition of honorary membership from many learned foreign and scientific societies. His work, in the form of papers on electro-magnetic theory, was published in the *Electrician*, London, for which publication that journal received a good deal of criticism from those who did not understand or appreciate the value of the papers.

From a memoir of Heaviside, written by Sir Oliver Lodge in the *Electrician* of February 13, 1925, we quote the following:—

"Heaviside had a wonderful instinct for grappling with the difficulties of a subject and giving it symbolic expression. He expressed the generation of electric waves in his own style; he treated of the motion of electric charges at different velocities, including those which equalled or even hypothetically surpassed the velocity of light. Everything relating to electrical induction, the energy of electric currents, the forces and fluxes of energy in the electromagnetic field, the self-induction of wires and the generation of waves, was elaborately worked out in his early papers. He invented a special system of vectorial algebra with which to deal with them. His mathematics often aroused the admiration of competent judges. And his three volumes on *Electromagnetic Theory* (published in 1893, 1899 and 1912 respectively) may be taken as a summary of his matured views on these subjects."

Heaviside was fond of tracing magnetic analogies to electric phenomena. He invented the terms "inductance," "reluctance," "reactance," "permeance," "permittance," and the like. Perhaps the most popularly known of his theories is that of the "Heaviside layer," which is considered responsible for the transmission of electric waves to the antipodes round the curvature of the earth. The contributions made to electrical engineering science by this remarkable man are of almost incalculable value, and it is therefore all the more a matter for regret that such genius was not earlier appreciated and given more adequate recognition.

ELECTRICAL FIRES

It almost invariably happens that when a fire of obscure origin occurs in a building wired for electric supply, some newspaper hastens to publish quite unfounded rumors of an electrical cause. Such a tendency is very regrettable, as suggestions of this nature give rise to unwarranted timidity in the public mind, creating

an impression that the use of electricity is inherently dangerous to property. A rumor of electrical origin was circulated about the recent conflagration at the Lincoln knitting mills, Melbourne, whereas the fire department, after a thorough investigation, has classed this outbreak as "cause unknown." Electricity has, of course, given rise to fires only too frequently, but the haste with which a certain class of people, who really know nothing about the matter, rush to blame the electrical installation evidently has its rise in the proverbial tendency to hang the dog with a bad name. But why pick on electricity every time? Naked lights, the misuse of benzine, gas leaks and carelessness with fire are far more potent causes of conflagrations, yet they are seldom falsely blamed in the first rumors. The trouble appears to lie in the facts that electricity is a great mystery to the man in the street and that it has caused fires.

Idle gossip cannot be wholly stopped, and therefore it appears that the only way to maintain public confidence in the safety of electricity is for the installers and operators of electrical equipment to squarely face the fact that electricity has caused fires, and to use every endeavor to overcome the defects which give rise to fires. Let it be stated most emphatically that every electrical fire is due to some defect. A sound installation, properly operated, will never cause fires. This is no wild statement but is the considered opinion, based on long experience, of the acting chief of the fire department in Melbourne. But statistics reveal a state of affairs that unfortunately almost justifies the statements of the electrical-fire scaremongers. During the year ended June 30, 1924, there were 1,147 fires in the Melbourne metropolitan area, and of these 30 were definitely traceable to electricity. For the year 1924-25 there were 1,155 fires and no fewer than 69 were electrical. The position merits very serious consideration. An analysis of the causes during the latter year shows that defective installations were primarily responsible for 48, carelessness in operation for 17, defective material for three and static electricity for one. Practically speaking, all causes may be grouped as either the responsibility of the installer or of the operator, and the installer must take most of the blame. Is it any wonder that the fire department was one of the strong advocates of licensing of wiremen? As far as carelessness is concerned, the person who leaves the electric iron turned on unfortunately cannot be controlled; but electricity should not get the blame for fires from this origin. The water supply is not blamed when someone leaves the bathroom tap turned on and floods the house. Where electricity will be blamed is through the shortcomings of those responsible for the installation of equipment. It is probable that the great percentage of the faulty-installation fires occurred

in buildings wired before licensing was brought in, but unfortunately these are not all. If installations are to be made safe it is not only necessary that the regulations be strictly enforced and rigid inspection tests be applied, but every electrician and engineer must be imbued with pride in his work, and be taught to recognise that the safety of property and even life depends upon the care and thoroughness with which he performs his job. Not until this is accomplished will the causes of electrical fires be cut down to those known as "unforeseen defects," and electricity cease from being a rumored menace.

THE RELIABILITY OF LONG TRANSMISSION LINES.

The trend of modern electric supply practice is towards placing the power station at a distance from the loading centre, it having been found more economical to transmit electrical energy than to transport fuel. With the majority of hydroelectric schemes there is, of course, no option as to where the power station shall be located, and it is exceptional to find good water powers close to centres of population. Therefore where hydroelectric power is being used to any extent the reliability of supply is absolutely dependent upon the continuous operation of the transmission link. Now transmission lines are peculiarly exposed to the effects of external conditions, such as weather, and therefore it is a difficult problem to keep them continuously in service. There is no doubt that the difficulty is thoroughly appreciated by engineers, but it appears that the promoters of schemes involving long transmission, and the public which puts its faith in power thus supplied, do not realise that such undertakings may not be 100 percent reliable. In a society that is becoming more and more dependent upon electricity, cessation of supply may be not only inconvenient and costly, but absolutely dangerous to life.

The actual condition of affairs is illustrated by statistics in connection with the operation of certain transmission undertakings in New Zealand. The public works department of the Dominion, which controls most of the important lines, to its credit is perfectly frank about the imperfections of its undertakings. In its recently issued annual report it records the number, duration, and cause of the interruptions to supply that have occurred on the different systems during the year. The figures, unfortunately, reveal a rather unsatisfactory state of affairs. To quote the worst cases: on the important Lake Coleridge-Christchurch line there were 16 failures of supply, while on the longer Lake Coleridge-Timaru line there were no fewer than 89. On the Horahora-Hamilton line 17 in-

terruptions are recorded, and on the Horahora-Waikino line there were 11 breakdowns. Certainly the majority of these cessations of supply were of short duration, but nevertheless the position is not too pleasant to contemplate. Some of the prospective large consumers, who intend taking the whole of their supplies from government hydroelectric undertakings, are becoming somewhat alarmed at the position, as is illustrated by recent remarks of a member of the Auckland power board. At present the board is taking a portion of its power requirements from Horahora, and the supply has been subject to certain interruptions. The member of the board is reported as saying that, "— the board feels that the line from Horahora is not as secure and immune from interruption as it should be, and considers that the government should take some additional precautions with regard to the supply." But the principal matter that is exercising the mind of the board is the fact that arrangements are being made for Auckland to take practically the whole of its supplies per transmission line from the Arapuni development, which is now under construction. If the Horahora supply cannot be made reliable, what guarantee is there that the Arapuni supply will be free from interruption?

The reliability factor appears to have been somewhat neglected of late in connection with hydroelectric developments. When the respective merits of hydroelectric power, generated in a distant plant, and fuel generated energy from a local station, are being discussed, the questions of capital expenditure and operating costs are often the only considerations. The possibility of the long transmission line introducing a weakness into the system is not given sufficient thought. Serious interruptions to supply may actually cost more to the community than the difference between the cost of the respective power schemes, quite apart from the factors of inconvenience and danger which cannot be given a cash value. In America, the home of the long transmission line, the question is being given very careful consideration, and the consensus of opinion now seems to be that any system employing long transmissions should have a steam standby station near the loading centre, of capacity at least sufficient for the maintenance of essential services. Some of the undertakings in New Zealand are adopting this practice, but in the enthusiasm for hydroelectric development there appears to be some danger of the necessity for steam as an auxiliary being overlooked.

Of course the provision of standby plant is not the only precaution that should be taken. Sound mechanical design of overhead lines, coupled with systematic routine testing, will greatly increase reliability. The hydroelectric department

of Tasmania, which operates several important long lines, has very few interruptions to service, principally owing to its excellent inspection system. The particular feature of the system is live-line testing of insulators and removal of faulty ones, with the line in service, before trouble develops to an extent sufficient to cause breakdown of the line. The soundness of the design and construction of the lines is evidenced by the fact that they stand up to very severe weather conditions with practically no trouble developing. Testing and inspection practice similar to that referred to should be adopted for every high tension line, to a degree proportionate to its importance. The cost would probably be recouped by the saving of heavy repair expenses, and by the additional encouragement to consumers offered by thoroughly reliable service.

Notes and Personals

The New Zealand railway department is landing an Edison electric storage battery car to test as a rail motor.

Control of the Brisbane tramways is to be taken over by the Greater Brisbane council from the tramway trust on Dec. 1.

Mr. A. B. Sewell, for some years with Amico Ltd., as sales manager, has accepted a like position with A. Beal Prichett (Aust.) Ltd., Sydney.

Mr. Ross Duggan, of the Westinghouse Union Battery Co., Swissvale, Pa., U.S.A., left Sydney by the s.s. Maheno on October 8, on his return voyage to America.

Mr. W. Strangward, secretary of the Melbourne tramways board, arrived in Sydney on September 19, by the Niagara, after a lengthy tour of Europe and America.

Mr. A. H. Hills, has resigned the New South Wales managership of A. Beal Prichett (Aust.) Limited, in order to commence business in Brisbane on his own account as a representative of electrical manufacturers.

Mr. C. F. Skinner has been appointed engineer and manager of the municipal electric supply undertaking at Kadina, S.A. He is a son of Mr. T. Skinner of the old Wallaroo and Moonta Mining and Smelting Co. He served his apprenticeship with that company, and was subsequently chief engineer at the smelting works.

The Commonwealth government is considering proposals for the payment of a bounty of £4 per ton for the manufacture of paper from Australian raw material. The Amalgamated Zinc Co. has been considering the establishment of pulp and paper works in the north-west of Tasmania, and the bounty proposal has been put forward with a view to assisting the establishment of the industry.

Mr. A. Maughan, managing director of the Australian General Electric Co. Ltd., returned to Australia by the R.M.S. Cathay, after an absence of nine months abroad. He visited the United States of America, England, France, Belgium, and Italy, where he studied the latest developments in the electrical industry.

The electricity committee of the Sydney city council has deferred until January consideration of the recommendation by Mr. H. R. Forbes Mackay, general manager, electricity supply department, that the price of electricity for industrial purposes be reduced by one farthing per unit as from June, 1926.

The Victorian government has decided that the present form of control of the Melbourne tramways will be continued. The terms of appointment of the members of the Melbourne and metropolitan tramways board expire on Nov. 1, but they are to be extended to a date to be fixed.

Mr. R. H. Bartley, chief engineer to the Auckland power board, has been appointed general manager to the board, in succession to the late Mr. A. Wyllie. Mr. Bartley, who is a native of Auckland, studied electrical engineering abroad. On returning to New Zealand he took an appointment as electrical engineer at Te Kuiti; later he became electrical and tramways engineer to the New Plymouth borough council. He joined the staff of the Auckland power board about three years ago.

Mr. H. R. Forbes Mackay, general manager of the electricity department, Sydney city council, has gone to England on business connected with the calling of tenders for plant for the council's proposed new power station. He will use as his headquarters in England the office of Messrs. Preece, Cardew, and Rider, consulting engineers, 8 Queen Anne's Gate, Westminster, London, S.W.1., and will welcome calls at this address from representatives of British manufacturers of plant and apparatus such as might be used by the Sydney electricity department.

Mr. R. G. Crivelli, M.E.E., of the Victorian electricity commission, is returning to Melbourne by the Naldera early in November, after twelve months spent in Europe in familiarising himself with recent progress in electrical engineering. Mr. Crivelli visited the principal electrical systems and manufacturers' works in Great Britain, France, and Sweden, and was one of the official Australian delegates at the international conference of large electrical systems, held in Paris in June. Mr. Crivelli spent three months on the staff of Messrs. Merz and McLellan in London and Newcastle, and devoted some time, whilst in France, to the study of electro-farming, which is progressing rapidly in that country.

Ocean Telegraphy as Influenced by Oliver Heaviside—I.

By M. C. Timms¹

It is proposed hereunder to discuss the progress of submarine telegraphy, and the influence thereon exercised by that remarkable man, Oliver Heaviside. It is inevitable that submarine telephony will also be touched on to a certain extent. The following symbolism is used throughout the article:—

Naut or nautical mile = 2,029 yds.

R = Resistance in ohms per naut.

K = Capacity in farads per naut.

L = Inductance in henries per naut.

D = Diameter of insulation in inches.

d = Diameter of conductor in inches.

W = Weight of conductor, lb. per naut.

w = Weight of insulator, lb. per naut.

l = Length of cable in nauts.

GP = Gutta percha.

G = Leakance in mhos per naut.

The core of a submarine cable is the insulated conductor.

The size of a cable core is indicated by weight of copper/weight of GP, lb. per naut: thus 500/320 means 500 lb. of copper and 320 lb. of GP per naut.

In the *Telegraph and Telephone Journal* for April, 1925, it was reported that, "There are about fifteen cables between North America and Great Britain, but all of them are obsolete, though not useless." This startling statement was made by a magnate of one of the great cable owning companies, and can be taken as authoritative. The subject is of sufficient importance to make the cause of this obsolescence worthy of examination.

The value of a telegraph cable is in direct proportion to the speed at which readable signals can be transmitted along it, and any plan by which the carrying capacity can be greatly increased without proportionately increased cost, will render all existing lines more or less obsolete.

The fifteen cables referred to represent a capital expenditure of several millions of pounds sterling. While some of them have been in use many years—at least two of them for fifty—others have been manufactured and laid within the last twelve years. The Atlantic cables of 1865 and 1866, which were the first commercially successful, were provided with a core designed to meet the conditions called for by the theory of transmission as enunciated by Lord Kelvin (then Prof. Thomson), in 1855. In some subsequent cables, as the density of traffic warranted, greater expenditure on material has become customary; for example, the core of the 1865/6 cables was 300/400, whereas cores of

700/360 have been used in recent years. Enormous improvements have been made in the practice of the manufacturing, submersion and working of cables, but the line itself remained in essentials unchanged from the earliest times, until last year (1924).

That any great change has now been made in cable design is mainly due to the work of Oliver Heaviside, whose death unfortunately took place early in the present year (1925). Mr. Heaviside at a comparatively early age, retired from practical telegraph engineering, and devoted himself to the mathematical development of Maxwell's theory, from the point of view of communication at a distance. From time to time he published his conclusions, but these were so much at variance with the ordinarily accepted notions of the time, that he was for many years a voice crying in the wilderness. Certain developments in telephony, however, indicated that the teaching of this prophet had borne fruit, and he lived long enough to know that an Atlantic cable had been laid, which embodied, as far as the resources of the day permit, the cardinal principles of his teaching.

Early Theory.

The pioneers of land telegraphy readily discovered that the dimensions of the conductor and, in underground circuits, the thickness of dielectric exercised considerable influence on the quality and speed of signalling. The experience was confirmed by the early submarine cables, several of which were laid from 1851 to 1857. Some principles to be followed were laid down by the brothers Bright, and as a result of painstaking experiment, and sound common sense, they had moved in the right direction. There were in those days no electrical units, as we now know them, and design was largely by rule of thumb.

First Atlantic Cable.

When Sir Charles Bright was appointed chief engineer to the Atlantic Telegraph Co., in 1857, he found that the board had ordered a cable having a core of only 107/261. This core had been decided on by the directors, partly as a result of advice from misinformed theorists, backed by at least one scientific genius, who, as far as this problem was concerned, singularly misconstrued the requirements. Sir Charles tried in vain to persuade the board to increase the weight of core, but the original decision was adhered to. Largely as a consequence this cable, which was successfully laid in 1858, was a total failure electrically. It is fairly familiar history that the company's electrician attempted to work the cable, using induction coils, producing about 2,000 volts, with totally unsuitable receiving

¹ Siemens Bros. and Co. Ltd., Melbourne.

apparatus. As a result, the dielectric was irreparably injured. Too late, rational methods of working were adopted, and this cable became a total loss. Had Professor Thomson's method of working, which was tested during submersion, been used commercially from the beginning, the cable might have had some useful life.

The unfortunate misconceptions which ruined the cable of 1858, exercised a baneful effect on submarine telegraphy. To the present day there exists what almost amounts to a superstitious attitude regarding the maximum voltage which is safe to apply to a laid cable; no regard appears to be given to the vast improvements in manufacture of the dielectric, which have taken place since 1858.

Scientific Treatment.

The long projected Atlantic cable attracted the attention of numerous men of science. The length involved, some 1,950 nauts, so far exceeded that of any line then laid, or projected, that abstract reasoning supplied the only guide for the design of such a cable. The electrical theory of the time was very primitive, and on the mechanical side, there was room for much conflicting opinion. Surveys of the ocean bed were almost unknown. The electrical problem was taken up by Professor William Thomson, of Glasgow, and a solution was published by him in a communication to the Royal Society in 1855, which for many years formed the only foundation on which cable practice was based.

The general form of a telegraph cable of fairly recent type is as shown in Fig. 1, which represents on an enlarged scale the cross section of a long deep sea cable for depths of upwards of 500 fathoms. In shallow water the weight of iron would be increased, the armoring being put on in two layers when the shallowest water is reached.

The Fundamental Constants.

The essential problem of a long cable is to ascertain the electrical condition of any part of the line at any time after an electrical change has been impressed on one end of the conductor. This condition will depend on the value of what are called the fundamental constants of the cable, and it is necessary, in order to forecast the performance of any proposed cable, to know to what extent the condition referred to is affected by a change made in the value of one or more of these constants. The fundamental constants are:—

Conductor resistance in ohms per naut, denoted by R ;

Electrostatic capacity in farads per naut, denoted by K ;

Inductance in henries per naut, denoted by L ;

Leakance in mhos or reciprocal ohms per naut, denoted by G .

Resistance at a given temperature is inversely proportional to the weight of copper per unit length. Ohms per naut at 75 deg. F. is given by the formula

$$R = 1183 \div W \dots \dots \dots (1)$$

where w = weight of copper in lb. per naut. As, for reasons to be given later, it is desirable that d , the diameter of conductor, be kept a minimum, a solid circular wire would be the most efficient electrically, though mechanically undesirable. As a compromise, the form of strand shown enlarged in Fig. 2—a stout centre

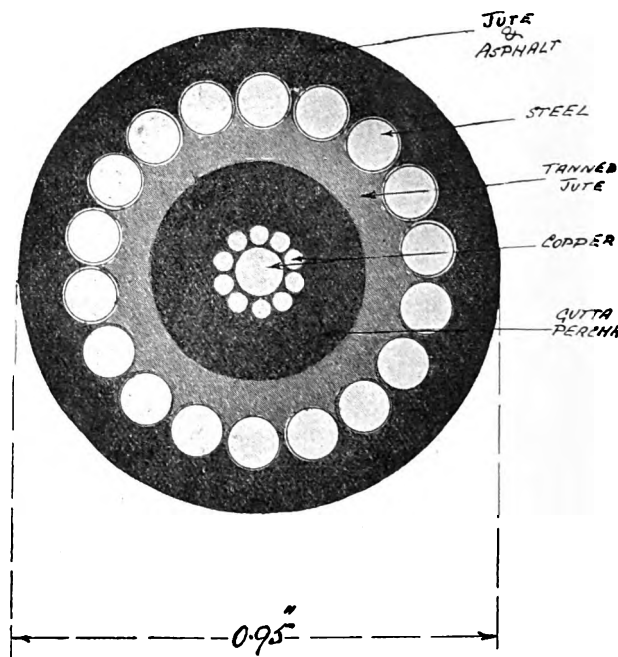


Fig. 1.

surrounded by a number of smaller wires—was originally devised by Messrs. Siemens Bros. and Co. Ltd. By this means an effective diameter, smaller than that of the equivalent seven strand is obtained, while the mechanical defects of a solid are avoided. In a later development, the small outer wires are replaced by copper tapes, resulting in a still further reduction of d . Long cables are usually laid at great depths—1,000 to 3,000 fathoms—and are thus exposed to temperatures as low as 35 deg. F. The value of R for a laid cable will therefore be considerably lower than that obtained at 75 deg. F. The total resistance of a cable 2,000 nauts in length having 500 lb. copper per naut will be about 4,370 ohms at sea temperature.

Electrostatic Capacity is a property of the dielectric, depending on the thickness and exposed area of same, also on the dielectric constant, k , of the material. The capacity of an ordinary gutta percha core is obtained by the formula

$$K = k.0.04476 \div \log \frac{D}{d} \dots \dots \dots (2)$$

where D and d are diameters of core and conductor respectively. The value of k depends on the quality and blend of gutta percha. It may have any value ranging between 3.25 and 3.5. For estimating purposes 3.4 is a safe value to adopt. Formula (2) then becomes

$$K = 0.152 \div \log \frac{D}{d} \cdot 10^8 \dots \dots (3)$$

Capacities thus calculated are the values at 75 deg. F., and atmospheric pressure. The value of K for GP is slightly decreased by subjection to pressure, and very slightly increased by decrease of temperature. As long cables are laid in very deep water, they are subjected to great pressure, and in addition, to low temperature, as already noted. As a result, the value of K obtained for a submerged cable may be expected to be higher than that obtained by calculation founded on the factory tests, at 75 deg. It has

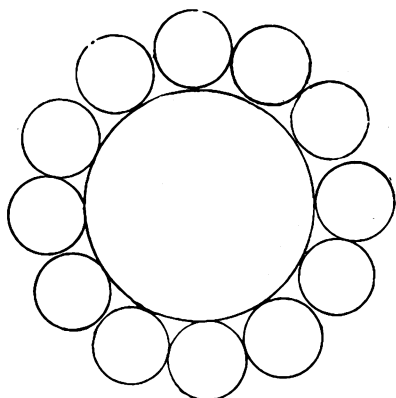


Fig. 2.
Siemens strand. 650 lb. per naut. Dia. .204 in.
1 wire, .122 in. dia. 12 wires, .041 in. dia.

been found experimentally that the capacity of an average type GP core is decreased by approximately 0.9 per cent per 1,000 fathoms, and increased 0.04 per cent per deg. F. The capacity of a cable 2,350 nauts in length, having a core of 350/300, is very approximately 880 microfarads.

Inductance, in the case of a cable as illustrated in Fig. 1, is extremely small. Its value is slightly affected by the presence of the iron sheath, but at most cannot be more than a few millihenries per naut. The value is difficult to estimate, owing to uncertainty regarding the path of the return current. With the speed of signalling possible on long cables, the changes of potential at the sending end are so slow that the value of $2 \pi f l$ is very small compared with the resistance, R , of even the heaviest conductor used. For this reason the inductance of ordinary telegraph cable has been regarded as negligible.

Leakance is nominally the reciprocal of insulation resistance. By this must be understood the effective value of the latter. At telephonic

frequencies the effective value of insulation resistance is very different from its steady current value,² but it can be readily measured at what is deemed to be the average frequency of telephonic currents. In the case of a telegraph cable, however, it is very difficult to say what is the average frequency; if such exists, it is very much lower than any telephonic frequency. Hence the effective insulation resistance in the telegraphic sense probably lies somewhere between the steady current value, and what would be obtained by using a low frequency alternating current. The uncertainty of the precise nature and effect of absorption causes the value of leakance to be very difficult to estimate. It is probably so low as to be practically negligible. The insulation resistance of a cable at sea bottom temperature and pressure after one minute's electrification may be 20,000 to 30,000 megohms per naut, equivalent to 10 to 15 megohms for a cable 2,000 nauts in length. Thus a steady current leakance of from one-tenth to one-fifteenth of a micromho could be expected for such a cable.

The K.R. Law

Lord Kelvin's theory of the submarine telegraph cable, already referred to, was founded on the assumption that both leakance and inductance were negligible, and that the conditions were entirely governed by the values of K and R . Having made these assumptions, Kelvin perceived that the problem was essentially similar to that of the conduction of heat through an elongated conductor, a problem which had been closely studied by Fourier. Kelvin applied the solutions which had been found for the thermal case to the problem in hand, and deduced a formula by which it is possible, knowing the fundamental constants, to calculate the current flowing out at the far end of the cable at any instant after an e.m.f. has been applied at the sending end. By this means the graph, known as the curve of arrival, may be obtained.

Fig. 3 shows the curve of arrival for a long ocean cable, and can be regarded as typical. This diagram was deduced from information provided by H. W. Malcolm in his work on the Theory of Submarine Telegraph Cables. It will be noted, on examining Fig. 3, that for a given period after the completion of contact at the sending end, apparently no current flows out at the receiving end. Largely owing to a misunderstanding, it became a general assumption that Lord Kelvin considered that this was literally the case, and that during the "silent interval," as it was called, actually no current was received, whereas in reality the current received is infinitely small, compared to that which flows a fraction of a second later. Lord Kelvin denoted the duration of the silent interval by "a." In

² See "Electrical Engineer," vol. 1, p. 453.

connection with this phenomenon, he said, "The curve so nearly coincides with the line of abscissae at first as to indicate no sensible current until the interval of time corresponding to 'a' has elapsed, although strictly speaking, the effect at the remote end is instantaneous." This statement provides no reason for the supposition that Kelvin regarded the silent interval as having any real existence.

Cable signals as received by the siphon recorder are actually portions of curves of arrival, and it is fairly obvious that the size and shape of signal received on a given cable will depend on the shape of its curve. The shape of the

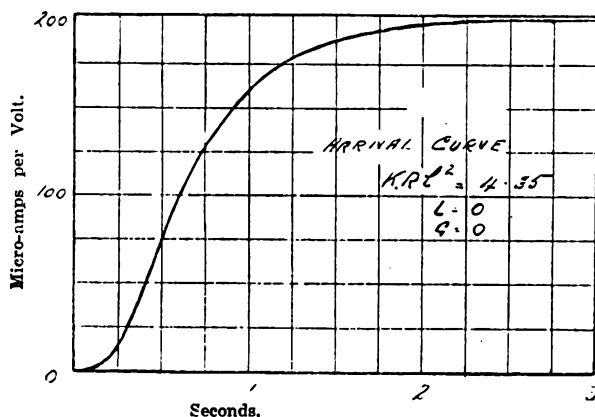


Fig. 3.

curve for any particular cable, or, in other words, the time required for the received current to reach a desired proportion of the maximum strength, is dependent on the fundamental constants, or in the words of Lord Kelvin, "We may infer that the time required to reach a stated fraction of the maximum strength of current at the remote end will be proportional to $K.R.I^2$." This is the KR law, sometimes known as the Law of Squares.

In the c.g.s. system of units, to which both ohms and farads belong, and in which $l =$ centimetres and $t =$ seconds

$$R = lt^{-1} \quad K = l^{-1}t^2$$

$$\therefore KR = t$$

KR is thus a time measured in seconds.

Significance of the KR Law

The significance of the law here quoted is that the speed at which a given quality of signal can be transmitted through a given cable is inversely proportional to $KR I^2$. The obvious deductions are:—

(a) For a given value of K and R the speed of working attainable will be inversely proportional to the square of the distance, or, in other words, halving the length of any particular cable would quadruple the speed attainable,

(b) In order to transmit a given quality of signal, a certain distance at a given speed, the product KR must be kept at a sufficiently low value. Hence long cables tend to have heavier cores than those of more moderate length. The limit is reached when the capital expenditure is such that the expected traffic can no more than pay the necessary interest and replacement charges.

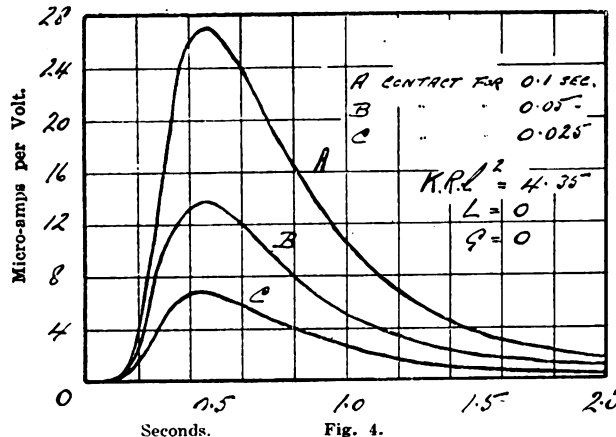
The essential problem of cable telegraphy arises from the difference between sent and received signals. This difference is caused by the combined effects of attenuation and distortion, and is for a given cable more marked at higher than lower speeds of signalling. It is the permissible difference between sent and received signals, which limits the speed attainable.

Attenuation or loss of amplitude is due to the combined effects of capacity and resistance. It is also increased by the effect of leakage, and can be compensated for by increasing the battery voltage. Attenuation within certain limits is not of great importance, because receiving instruments can be made extremely sensitive, if necessary, and numerous magnifying devices have been utilised with success.

Distortion, caused also by the combined effects of resistance and capacity, represents by far the greater part of the difficulty. Suppose one pole of a battery, which has its other pole to earth, be applied to the end of a long cable for a certain time, and then withdrawn, the cable at the same time being earthed, a square topped wave of e.m.f. is impressed on the cable, tending to produce a dot or dash, according to the polarity. Due to the effect of distortion, the wave of received current will be very far from square topped. Fig. 4 shows graphically the received current through a cable having a $K.R.I^2$ value of 4.35, due to various applications of a sending battery. The first part of the curve up to the peak is a portion of an arrival curve, as shown in Fig. 3; the later portion, the decay of the curve, represents the flowing out of the charge accumulated in the cable. The decay of the current shown in Fig. 4 assumes the sending end earthed after completion of the signal. If this were not done, the decay of the curve would assume a flatter shape, being very much more prolonged. The three curves, A, B and C, each represent a successively higher speed of signalling, and demonstrate the progressive effect of distortion, or gradual flattening out of the wave. Fig. 4 is derived from the same source as Fig. 3.

Fig. 5 represents the letter S—three dots—as received when sent at a certain speed through cables having KRI^2 values of 1.0 and 2.5—curves I. and II. respectively. Curve III. represents the

square topped wave of e.m.f. applied at the sending end to produce the effects in I. and II.³. The flattening out process tending to merge three dots into one prolonged wave with an upward tendency is due to the gradually accumulating potential of the cable. This effect is in practice somewhat minimised by the use of block condensers at each end of the line, originally introduced to exclude earth currents. A further improvement is obtained by so arranging the signalling key that the signal impulse is immediately followed by one of opposite polarity, which partially neutralises the charge impressed



by the signal. This is known as Curbed signalling, and is now universally used on long cables.

Consequences of the KR Law

The density of cable traffic being heaviest in the North Atlantic, it follows that North Atlantic cables are designed for greater speeds, and thus have heavier cores than cables of similar length in other parts of the world.

The essential problem presented by distortion is to so proportion the constants of the cable, K and R, that the arrival curve shall, as nearly as practicable, resemble the square topped sending voltage curve. The value of the product KR can naturally be reduced by reducing either or both of the factors, that is by increasing the weight of copper or GP or both. The relative advantages of either course will be discussed later. In some instances the length between stations is so great that, in order to attain a reasonable speed at all, specially heavy cores are used, as exemplified by the Pacific Cable Board's Bamfield, British Columbia, to Fanning Island section, laid in 1902, which has a core of 600/340, the length being 3,458 nauts, and the Western Telegraph Co.'s Ascension to Buenos Aires section, 3,144 nauts, which has a core of 700/360.

The limiting speed of signalling is very ambiguous to define. In transit the signals are,

³ Diagram from Fleming's "Propagation of Electric Currents in Telegraph and Telephone Conductors," calculated by the late G. B. Dyke.

as noted, affected in two ways: in size or amplitude by attenuation, in shape by distortion. What are the limits, is naturally the first question. In size the limit is fairly definitely fixed by the average power of human eyesight, and sensitiveness of recorder. The limits of distortion are, however, dependent greatly on the skill and experience of the operator; signals quite meaningless to the beginner will be easily read by an old hand. This applies to both recorded and indicated signals. Size of signal in cable telegraphy is secondary to form of signal.

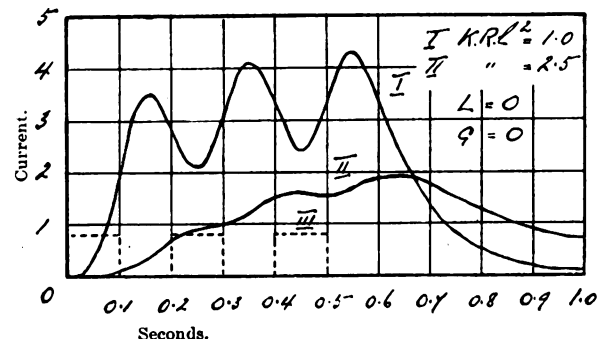
For these reasons it has been found impracticable to set a scientific standard for cable transmission as has been done in the case of telephony. Estimates of probable cable speeds are made by the use of empirical formulae, of which there are several. One such rule, due to the late F. Jacob, is as follows:—

If S is the number of five letter words which can be sent per minute when using the siphon recorder as receiver, then

$$S = \frac{120}{K.R.L^2} \dots \dots \dots (4)$$

The conductors of cores are naturally of copper. The insulating material is invariably some form of gutta percha, this material being the only known dielectric capable of retaining its properties indefinitely under water, without the assistance of a watertight metal sheath. In early days the weight of GP usually was greater than that of copper; the weights used were later equalised, and subsequently the conductor exceeded the insulator in weight, which is generally the case in modern practice.

By volume copper and GP are approximately equal in cost, so that if the cost of the core is fixed the outer diameter, D, is also decided.



Because R varies inversely as d, and K only inversely as log D/d, it is economical to make d as large as possible. The limit to the size of d for a fixed D is set by what is considered the safe minimum thickness, t, of dielectric. An accepted rule is that t should not be less than as obtained by the formula

$$t = 0.25N \sqrt{d} \dots \dots \dots (5)$$

It has been shown⁴, that when the diameter of core is fixed KR is a minimum when

$$D = 1.65d \dots \dots \dots (6)$$

Assuming the cost of GP by weight to be six times that of copper, it has been shown⁵ that the highest speed for a given cost will be obtained by a core in which the conductor weighs approximately four times as much as the insulator. Such a core as 1,041/254 fulfils this requirement, and the ratio D/d would be 1.7 or approximating to Price's standard. The thickness of GP would, however, be only 0.09 in., not sufficient to provide the necessary mechanical strength; to satisfy formula (5) this should be 0.127 in.

The heaviest core so far used, 700/360, has a weight ratio of 1.94 and a diameter ratio of 2.23, the thickness of dielectric being 0.13. Sayers has shown that the difference in commercial efficiency between a cable having such a core and one having the theoretically most economical core is only seven per cent. A core 700/360 only represents two-thirds of the capital value of a cable in which it is embodied.

Limitations of the KR Law

The KR law being enunciated in the earliest days of cable telegraphy, and the first long cables commercially successful having been designed in order to satisfy it, its prestige has for many years been exceedingly great, so great that the tendency has been in some quarters to carry reliance on it to absurd lengths, even to its application in telephony. This law, in its simple form, is only capable of very limited application, because it entirely ignores the effects of inductance and leakage, and assumes both ends of the cable put to earth without inclusion of sending or receiving apparatus.

The KR law was never intended to be a final solution of cable telegraphy. It was the result of the application of scientific methods to a simple insulated conductor of great length, and represented an infinite advance on any theory available to guide the cable engineers of the time. Except for the work of one man, the theoretical side of the subject has remained almost unstudied where Lord Kelvin left it in 1855. (To be concluded)

Portable Transformer Substations

A number of portable transformer substations for use on the Italian state railways have been built by the Officine di Savigliano, Liguria, Italy. Their duty is to replace the ordinary substations in case the latter have to stop working through any cause, or they are employed when it is necessary to increase the capacity of the substations in the event of exceptionally heavy loads. They are consequently designed to work in parallel with the ordinary railway substations under all the variations of current demand which may occur. The absolute necessity of restricting within given limits the weight of the component parts and the space they were to occupy rendered the design of the plants somewhat difficult; the problem, however, has been solved successfully.

Each portable transformer station is carried on a railway bogie wagon frame, having two six-wheeled bogies, making it possible to travel over the normal gauge system of the Italian railways at a speed of 31 miles per hour coupled to ordinary trains. The plant is designed to work in the open without any covering whatever. The principal component is a three phase oil cooled transformer with capacity of 2,600 kv.a. at 16 2/3rd cycles, arranged for supply pressures of 102,600 volts with star connection or 59,800 volts with delta connection. The secondary voltage is adjustable by steps from 3,700 to 4,466

volts at full load and 0.8 power factor. There is a triple pole oil switch with overload relay on the high tension side, equipped with condenser insulators for connection to the feeder line. On the low tension side is another t.p. oil switch. Both these switches are arranged for hand or electric remote control.

An apparatus compartment is located at one end of the car. This contains the switchboard for the remote control of the primary and secondary switches; a motor-dynamo set for charging a storage battery for lighting and for the auxiliary apparatus, the set being supplied with current from a small transformer; two switchboards connected with the charging and the service of the battery; and the recording instruments to control the working of the plant, supplied with current from transformers located on the roof of the cab. On one of the outside platforms is a fan worked by a small electric motor, or by hand, for the circulation and drying of the air inside the transformer.

The portable substation complete weighs about 90 tons, and the six which have been built have satisfactorily passed the following tests: Ten direct and consecutive short circuits, an overload of 150 per cent, and an insulation test at 210,000 volts. These transformer stations are at the present time in regular service on the Italian railway system for meeting increases in traffic where stationary substations have not yet been built.—"Engineering."

⁴ W. A. Price, "Electrical Review," vol. 41, p. 190.
⁵ R. M. Sayers, "Electrician," vol. 74, p. 155.

The Liquid Rheostat—II.

By W. Wilson, M.Sc., B.E., M.I.E.E.

Electrolytes

In most cases met with in practice, the electrolyte consists of a weak solution of washing soda, which is a somewhat impure form of sodium carbonate. Other salts that may be employed are bi-carbonate of soda, common salt, salammuniac and caustic soda. Particulars of the conductivity of electrolytes formed by these are given by the curves in Fig. 9. There are two sets of curves in this diagram. Those resembling a hyperbola give the resistance in ohms per inch cube of the various solutions at normal temperature, according to their strength. The radiating lines give the reciprocal values of these, viz., the conductivity in mhos per

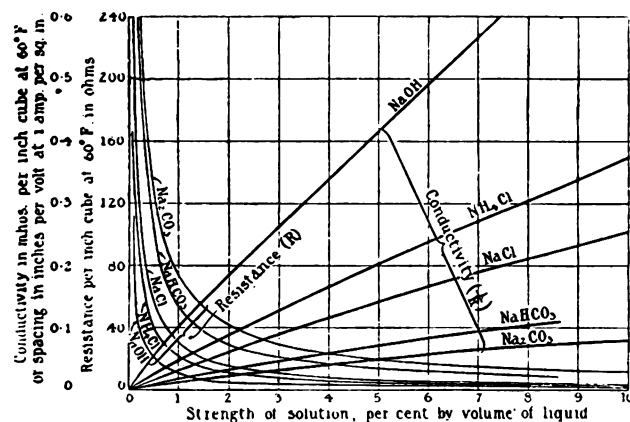


Fig. 9. Resistances and Conductivities of Electrolytes at various degrees of concentration.

inch cube; and they also express the spacing of the electrodes in inches per volt at a current density of one ampere per square inch.

Following the general rule for non-metallic resistors, liquids decrease in resistance with temperature. The curve given in Fig. 10 shows the rate at which the resistance falls off, that at 60 deg. F. being regarded as 100 per cent. This curve is sufficiently correct for any water solution.

Design

The design of a liquid rheostat is chiefly a matter of ascertaining the maximum safe current that may be passed through a given area of the electrodes; the permissible duration of the current, which is governed by the amount of energy that can be absorbed in a given time without causing overheating; and the maximum safe voltage gradient through the electrolyte.

With regard to current density, conditions until recently have been somewhat chaotic, since various authorities have laid down widely different rules in this respect. For example, the maximum safe current that can be passed per

square foot of electrode area has been variously estimated to be 30, 100, 144 and 400 amperes. At the present time, most electrical pocket-books give a figure of one ampere per sq. in., corresponding to the third of the above estimates; but this as well as the other figures quoted, is now known to be very much lower than is permissible in practice.

An investigation by the author† described tests made with both alternating and direct current, in which current densities were reached of over 11,000 amperes per sq. ft. with alternating and 5,760 amperes per sq. ft. with direct currents, without causing any sign of breakdown. Voltage gradients up to 2,400 volts per

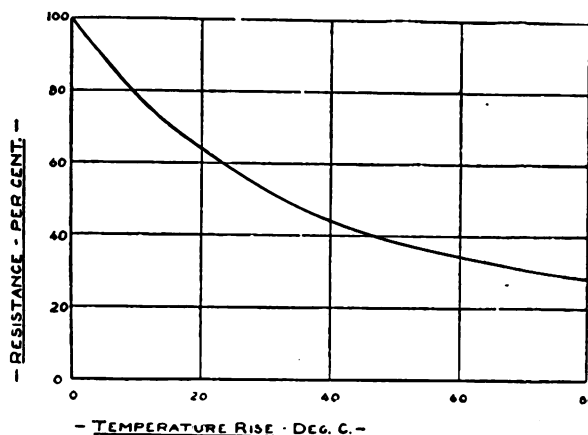


Fig. 10. Temperature-Resistance Curve for Aqueous Solutions

in. were also imposed with impunity. These tests effectively showed that the limitations originally observed were quite unwarranted. As a matter of fact, excessive caution with regard to current density was engendered by observation made upon the results of conducting high tension current into and out of pure water by means of pipe electrodes, from which the lines of flow were radiating, causing a very large proportion of the total energy to be liberated at the surface of the electrode. A sudden and intense local evolution of steam was thus brought about, which was a sufficiently poor conductor to interrupt the current completely at frequent intervals. This state of things does not exist in commercial rheostats, in which the current flow is designed to be as nearly along parallel lines as possible.

During the above mentioned tests, a sufficiently good circulation of the electrolyte was promoted to prevent serious ebullition. In practice, the production of heat would demand more liquid than could be contained in such a small rheostat

†Journal I.E.E., Vol. 60, No. 306, Feb. 1922.

as would employ anything like the high current densities that were then attained. A density of about 3,000 amperes per sq. ft. is actually utilised in certain marine liquid regulators; but it will be generally found that densities of the order of 1,000 amperes per sq. ft. are the most that will be required in practical work.

The second factor that requires determination is the heat capacity. This is generally expressed in h.p.-minutes, being the product of the average

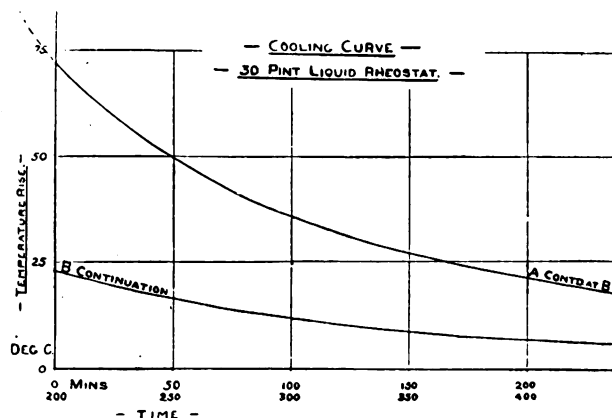


Fig. 11. Cooling Curve obtained by experiment from Rheostat in Fig. 2., by filling with Boiling Water and allowing to cool naturally

h.p. passed through the rheostat and the number of minutes which elapse before the temperature of the liquid is raised to a given value. The value has been fixed at 50 deg. C. (90 deg. F.) by the British Engineering Standards Association.

Now almost exactly three-eighths of a pint of water is raised 50 deg. C. by one h.p.-minute; and this relation will enable the amount of liquid to be used for the absorption of a given amount of energy to be found. For very rough calculations it may be assumed that the h.p.-minutes for a liquid are three times the quantity of the latter in pints; this relation will actually give the amount of energy that will raise the temperature through 100 deg. F. In the case of an actual rheostat, the heat absorbing power of the metal should also be taken into account, and this is done by adding its water equivalent to the figure representing the quantity of water. This may be simply carried out by weighing the amount of iron in pounds and adding one-tenth of this to the volume of the liquid in pints.

For example, in the case of the rheostat illustrated in Fig. 2, the amount of liquid was 30 pints, and the tank and electrodes weighed 70 lb. The water equivalent of the iron was therefore 7 pints, and the total amounted to

37 pints, giving a thermal capacity of $37 \times \frac{8}{3}$, or 99 h.p.-minutes.

Thus the heat absorbing power is given, and the performance of a rheostat may be determined

by comparing this with the energy given off by the starting or the control of a motor. Employing the above example, the energy liberated is half the total taken from the line during the whole starting period, the motor absorbing the other half. If a single start is made, or several in quick succession, followed by a long interval during which the starter will have time to cool, the capacity of the latter will at once be given by simple arithmetic. But if the duty required is periodic, the rate of cooling during the intervals must be known. This can be found by plotting a curve such as that shown in Fig. 11, whereupon temperature charts such as are shown in Fig. 12, may be compiled. In these, the motor is supposed to be started every 16 minutes, the duration of the starting period being one minute. The rising portions of the curves are obtained by the calculation just given, while the descending components are copied from the corresponding portion of the cooling curve in Fig. 11, at the temperature when cooling begins in each case. These curves have been drawn for three capacities of induction motor, viz., 50, 60, and 75 h.p. respectively, supposed to be fully loaded, and the diagram shows the rate at which the temperature of the liquid will rise, and therefore the number of starts that can be given before any prescribed temperature rise has been exceeded.

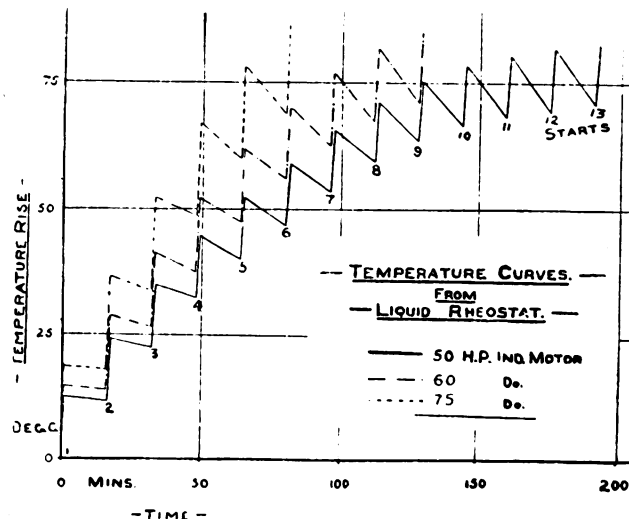


Fig. 12. Curves showing Changes of Temperature due to alternate heating and cooling, using Rheostat in Fig. 2 with three capacities of Motor.

If a model of the starter is not in existence, and hence the cooling curve cannot be found by experiment, it can be constructed approximately by erecting ordinates at 10 minute intervals, and making these diminish by a constant ratio, K, which may be found from the following equation:—

$$K = 1 + \frac{0.00234 S}{V + 0.1W}$$

Where S = Cooling surface in sq. in.
 V = Volume of liquid in pints.
 W = Weight of iron in pounds.

Liquid rheostats for controller or other duty may be calculated in a similar manner, including the provision of water circulation. It will be found that between 3 and 6 gallons of cooling water are required per h.p. dissipated per hour. The pressure of the supply should not exceed 50 lb. per sq. in.

Rating

The B.E.S.A. standard ratings are given in the following table:—

Standard Size No.	H.P. Minutes per 30 mins. taken from line.	Maximum rotor current amperes.
1	50	150
2	100	250
3	200	500
4	375	750
5	750	750
6	1,200	1,250
7	2,500	1,250

In this the first four are for either d.c. or a.c., while the remaining three are for a.c. only. It will be observed that the rating is not according to the amount of energy to be absorbed by the starter, but according to the total energy taken from the line, which has already been shown to be double the former. Thus the starter will be capable of operating against conditions twice as severe as stated in the table. Hence a standard model, designed to carry out a given sequence of single starts, will be able to make twice as many as these, an amount of latitude that will cover a number of contingencies that may occur, such as, for example, the failing of the power supply for a short period immediately after starting has taken place.

The B.E.S.A. regulations specify that the above conditions must be fulfilled for two successive half-hour periods without the temperature rise exceeding the 50 deg. C. already laid down. Thus the rated size of a starter necessary for a given service is given as follows:—

$$\text{H.p.-minutes per 30 minutes} = \text{H.T.} \frac{S}{F} \times N$$

Where H = Rated h.p. of motor.

T = Starting time in minutes.

S = Starting torque.

F = Full load torque.

N = No. of starts per 30 minutes.

For example, to find the size of starter for a motor rated at 40 h.p., to start against 150 per cent full load torque once every 10 minutes, the starting period being half a minute:

$$\frac{40}{2} \times 1.5 \times 3 = 90 \text{ h.p.-minutes.} \dagger\dagger$$

††British Standard Specification No. 140 (1923 Edition).

The conditions, therefore, would be met by a No. 2 size starter in the table.

Liquid Earthing Resistances

A few words should be said on the subject of liquid earthing resistances, the use of which, in place of the more usual cast-iron grid or carbon powder types, appears likely to develop. The conditions under which these work are almost the exact opposite to those in the case of the starter or controller; for whereas the latter are in circuit frequently, but need not have by any means a constant resistance, the former are only employed when a fault develops in the system, and they must be relied upon to be of the correct value. They must also be suitable for use on extra high tension systems; and since they serve as safeguards to the installation to which they are connected, they must be entirely reliable.

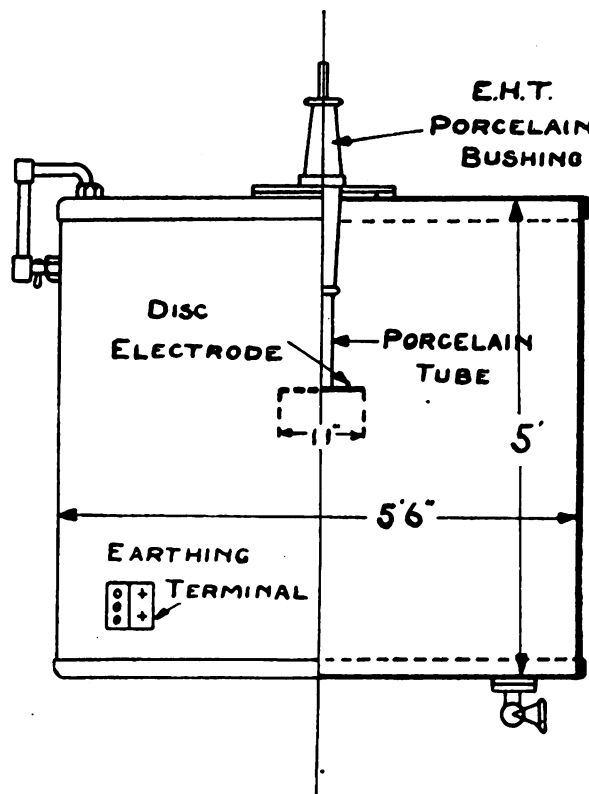


Fig. 13. Liquid Earthing Resistance for 33,000 volt System

Now it was long considered that a liquid resistance could not be employed with any hope of satisfaction under such conditions, the very high voltage gradients often demanded being pronounced by even experienced engineers to be an insuperable obstacle. However, the author has shown that provided the lines of flow are designed to be parallel, or approximately parallel, as distinct from radiating, no difficulties whatever need be feared. The design can then proceed along the lines already laid down.

By way of example, one of a number of earthing resistances designed by the author for a British super-station will be described. The voltage concerned was the highest yet in use in the British Isles, namely, 33,000, and a resistance of 95 ohms was demanded, which would pass a single-phase current of 200 amperes to earth for two minutes without the electrolyte exceeding the specified rise of temperature. To secure constancy, a galvanised iron tank 5 ft. in diameter by 5½ ft. high was used, the metal being ¼ in. thick. A very dilute solution of zinc sulphate was used as the liquid, while the inner electrode consisted of a perforated disc 11 in. in diameter. In this, although the flow-lines are not strictly parallel, yet they are prevented from concentrating unduly at any part of the electrode surfaces, and thus the production

of heat is diffused fairly well throughout the liquid, especially in the lower portion.

It should be explained that Welsh water, which is brought in huge pipes into the Midlands for water supply purposes, is used for making up the electrolyte. This has a specific resistance of 5,000 to 8,000 ohms per inch cube, on account of its great degree of purity, as compared with the average usually assumed for ordinary water of 2,500 ohms, and a value of about 150 to 300 ohms for canal water. A very small quantity of the zinc salt is added to this to adjust the resistance to the required value, involving a reduction of, roughly, 50 per cent. A simple blow-off valve is fitted to cope with the evolution of steam if the two-minute period should by any chance be exceeded. The general arrangement of the resistance is shown in Fig. 13.

Electricity Supply in Great Britain

The British electricity commissioners have just published their statistical abstract showing the progress made during the year 1924-25 in the economical generation of electricity. The report deals with the twelve months ended March 31 last, during which returns were received from 584 generating stations, which is 46 more than in the preceding year. The increase is in part attributable to certain undertakers having on this occasion sent in returns for each of two or more generating stations instead of a consolidated return for the whole. During the year 23 new generating stations were brought into service. The total output was 7,415 million units, of which 7,090 millions were generated in steam-operated stations. The corresponding figure for the previous year was 6,342 millions of units. These figures refer to public supply undertakings, and it is estimated that about half as much is generated in private plants. The fuel consumed was 8,001,687 tons in 1924-25, and 7,561,991 tons in 1923-24. The increased output of some 11 per cent has thus been achieved with an increase of less than 6 per cent in the fuel consumption.

The average coal rate per unit generated was 2.53 lb., as compared with 2.67 lb. in 1923-24, and with 2.78 lb. in 1922-23. This steady improvement is gratifying, but there is still much room for substantial savings in fuel costs, since the coal rate has now been reduced at the best station to 1.51 lb. per unit generated. This is the figure returned for the new Barton station at Manchester, which is, moreover, credited with a thermal efficiency of 19.85 per cent. Both this figure and the coal rate are fractionally worse than recorded for this station in the preceding

return. That, however, represented but six months' working, for which a coal rate of 1.48 lb. per kw. hr. and a thermal efficiency of 20.33 were claimed.

The second place in the list is taken by Carville, where the coal rate was 1.70 lb. per kw. hr. and the thermal efficiency 18.78 per cent. This is a very remarkable showing for an old station, which has been responsible for so much pioneering work in the economical generation of electricity. Last year this station was credited with a coal rate of 1.81 lb. per kw. hr. The improvement made reflects the greatest credit on the station engineers, since it is much more difficult to modernise an old station than to build a new one.

Last year the second place was accorded to the North Tees station, where some very bold departures have been made from normal practice, but no mention is made of this venture in the present report. Neither does the Dalmar-noch station appear, at least, explicitly, but the return does refer to a large station in the Glasgow area at which the coal rate was 1.82 lb. per kw. hr., and the thermal efficiency 17.55 per cent.—"Engineering."

An extensive shut-down occurred recently on the Melbourne suburban electric supply system through the burning out of a frequency changer at the power station of the Melbourne Electric Supply Co. The machine at fault is of 5,000 kw. capacity and converts from the 25-cycle supply purchased from the railway department to 50-cycle energy for distribution. The generator end was completely burnt out. Supply, however, was restored in a very few minutes.

The Operation of Three Phase Induction Motors from Single Phase Supply

By W. H. Gregory*

Single phase a.c. distribution has been used fairly extensively in Australian cities, the largest system being that in the suburbs of Melbourne. The present tendency, however, is to change over to three phase supply, and it is therefore customary for the electrical firms to supply three phase motors to their clients, so that when the systems are changed it will not be necessary to change the motors. The question thus arises as to the best means of starting three phase motors from a single phase supply, until such time as the three phase supply will be available. The usual method is by means of a phase splitter,

be started by means of a phase splitter, and the others started through this motor which is called the master motor (Fig. 2).

The function of the three phase master motor is to supply the other motors with a polyphase current of sufficient strength to start them as ordinary three phase motors. The master motor may be considered as a phase converter taking energy from the single phase supply and converting it to polyphase energy. As the master motor is not only required for starting purposes but also for delivering mechanical load, care must be taken in starting large motors not to overload it. As each motor is started it automatically becomes a master motor helping to

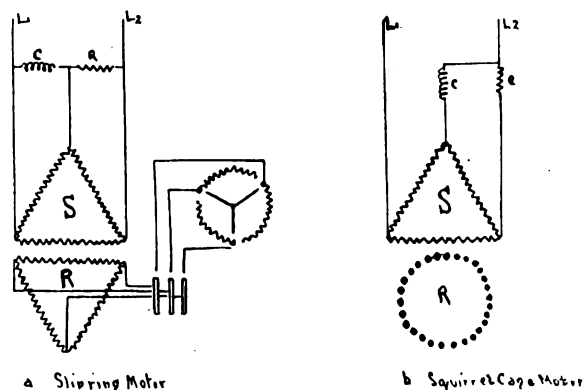


Fig. 1

Fig. 1, which consists of a suitable switch controlling a non-inductive resistance and choke coil. The connections are arranged so as to give a difference in phase angle between the voltages supplied to different phases of the motor, the phase angles depending upon the values of the reactance and resistance.

The difference in phase of the two e.m.f.'s sets up a rotating field of sufficient strength to enable the motor to get up to speed, after which the phase splitter is cut out, and the motor runs direct on the single phase supply. The h.p. available from a three phase motor when run under these conditions is about 65 per cent of its rated three phase h.p., so that due allowance must be made when purchasing a three phase motor that the correct capacity is obtained for the work required. When several motors are installed in the one factory the starting may be done as previously described, but as the main object is to install the motors so as to be ready for a three phase supply, they are wired for three phase operation and started with their own three phase starters, except that one will

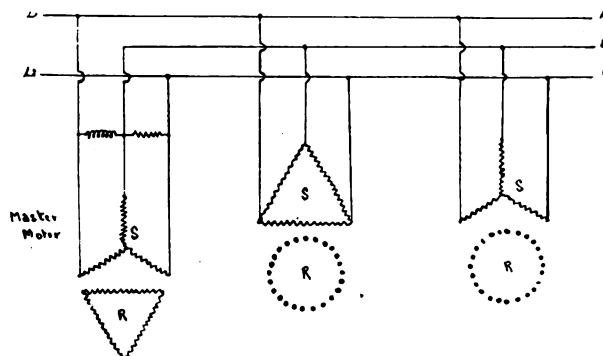


Fig. 2

deliver polyphase current into the system for starting the other motors, so that when there is a large installation of motors connected to a single phase supply and wired for three phase operation there will be a considerable exchange of currents between the lightly loaded motors and the motors fully loaded, thereby helping to maintain a fairly balanced local polyphase system. Once a system is installed care must be taken that the master motor is not reversed in rotation, as this will reverse all the motors connected to the system. Therefore if it is found necessary to reverse the master motor, two of the phases feeding the other motors must be reversed so that their rotation will remain the same.

An understanding of the action of a three phase motor when run light from a single phase supply acting as a phase converter, and of the nature of the polyphase currents available will be understood from the following experiment carried out on a $7\frac{1}{2}$ h.p. 400 volt three phase motor. The motor was connected to a balanced load, as shown in Fig. 3, and the voltages measured across each phase under different loadings. The voltage variations were as shown in Table 1.

*Aust. General Electric Co., Melbourne.

Table I.

Line Currents.						Line Volts.		
						AC	AB	BC
0	..	..	..	..	..	400	378	386
3	..	..	..	..	..	400	380	360
6	..	..	..	..	..	400	384	330
8	..	..	..	..	..	400	390	318
10	..	..	..	..	..	400	394	290
14	..	..	..	..	..	399	390	270
16	..	..	..	..	..	398	384	242
18	..	..	..	..	..	398	382	230

It will be seen that the voltage regulation due to load on line AC is practically constant, as is the voltage on line AB, while that on line BC drops very rapidly as the load is increased. The motor during these tests, especially when the high values of current were being taken from it, gave every indication of carrying a heavy

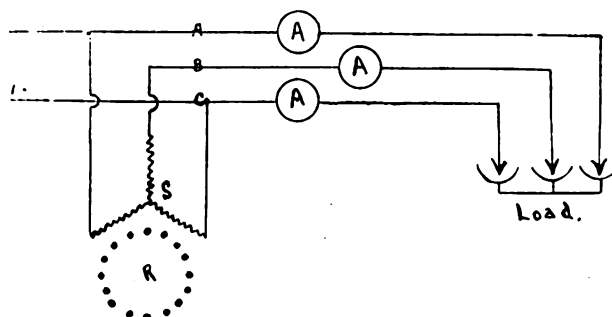


Fig. 3

overload, showing that it would be an easy matter to overload the master motor if it were not of sufficient capacity for starting large motors. It is advisable, if there are many motors, to start the smaller ones first, so that there will be greater reserve of polyphase current available for starting the larger motors.

There is a considerable difference of opinion as to the h.p. available when motors are operated under this system, but it will be fairly safe to assume that at least 65 per cent of the three

phase rated h.p. is available. The overall efficiency of the system will be only slightly lower than if the motors were running on true three phase power, the increased loss being the power consumed for phase conversion.

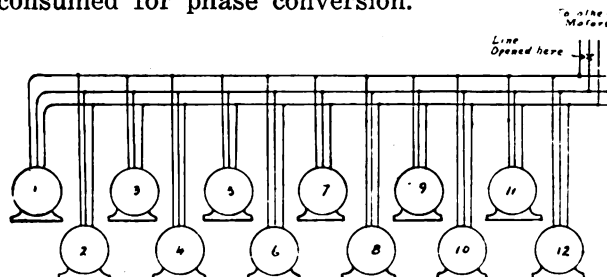


Fig. 4

The figures of current and voltage in Table II. were obtained from 12 motors forming part of a system of 29 motors operating on single phase supply. The 12 were first run as a local poly-phase system; then the whole 29 were switched in, readings being taken in each case.

It will be noted that there are considerable differences in the individual motor currents and

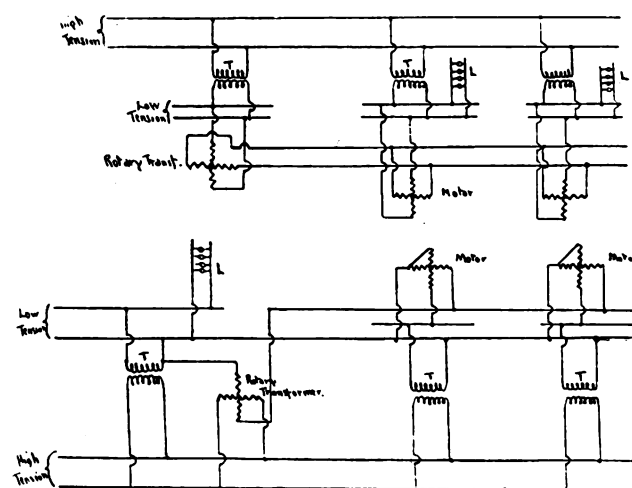


Fig. 5

Table II*

Motors			Current per Line						Volts per Line					
			12 Motors			29 Motors			12 Motors			29 Motors		
No.	h.p.	r.p.m.	A	B	C	a	b	c	AB	BC	AC	ab	bc	ac
1	50	970	30	8	40	32	10	42	328	344	400	352	376	400
2	50	730	25	6	30	32	12	42	336	344	400	380	368	400
3	50	730	25	6	30	28	10	30	312	360	400	328	384	400
4	20	785	12	5	20	14	8	22	320	356	400	368	376	400
5	10	1440	3	1	4	10	2	10	300	352	400	328	368	400
6	60	960	28	20	40	30	12	42	560	580	400	520	540	400
7	50	960	25	6	30	33	8	36	340	368	400	344	384	400
8	10	1440	25	10	30	10	1	11	300	352	400	328	368	400
9	40	960	25	10	20	28	12	35	240	352	400	328	368	400
10	10	730	15	5	15	15	9	19	280	344	400	300	360	400
11	40	960	30	10	32	30	10	35	308	352	400	328	368	400
12	40	960	22.9	10.9	29	25	9	30	320	352	400	328	360	400

*Figures by courtesy of Mr. Tarrant, chief electrical engineer, MacRobertson's, Melbourne.

voltages, so that it would appear from these unbalanced conditions that the motors are not operating at greatest efficiency. Any unbalanced polyphase system of currents or voltages may be resolved into two balanced polyphase systems, one having positive phase rotation and the other negative phase rotation. Thus there is a synchronous rotating m.m.f., opposite to that produced by the current having the positive phase rotation, which reduces the efficiency of the system.

This system of operating three phase motors on single phase supply is often referred to as

the Ferraris-Arno system, but a reference to the diagrams of Fig. 5, taken from the original patents of Galileo Ferraris and Riccardo Arno, will reveal certain differences. In the first patent, granted in 1895, the master motor or phase converter was run light, its only function being to generate polyphase currents for the apparatus connected to the system. The capacity of the converter was the same as that of the connected polyphase load. Early in 1896 an extension to the existing patent was granted. In this the converter was the same as that of the connected and mixed loads, and was wound to compensate for regulation at different loads.

The Synchronous Induction Motor

The synchronous motor offers advantages over other types of a.c. machine for heavy drives where the load is steady and constant speed is required. It runs only at one speed, its efficiency is high and its power factor may be regulated to actually improve that of the supply system

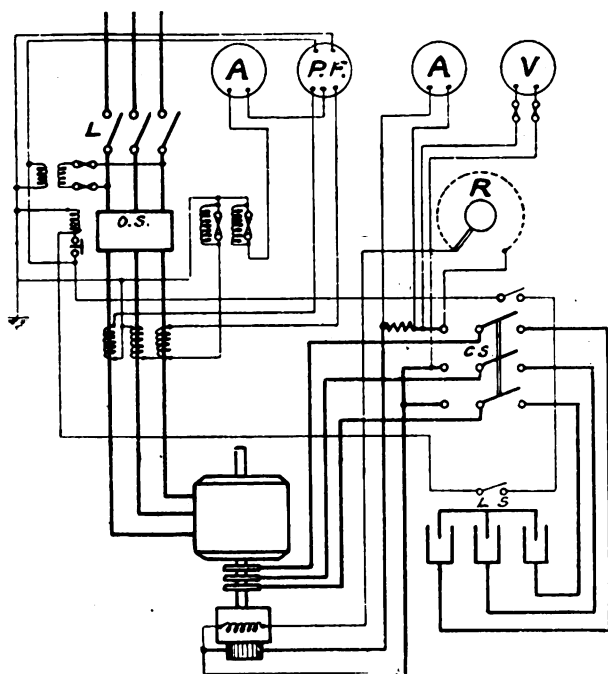


Fig. 1. Diagram of Connections for Synchronous Induction Motor

from which it receives its energy. It has, however, the serious disadvantages that it cannot be started under full load, and that an overload is liable to pull it out of step and thus cause a stoppage. A type of motor has been developed of recent years, however, which has the advantages of the synchronous motor without its disadvantages. This is the synchronous induction motor, variously known also as the

auto-synchronous and asynchronous-synchronous motor. In it the starting characteristics of the wound rotor type induction motor are combined with the good running qualities of the synchronous motor, the combination being effected at a very small loss in efficiency. Many firms are now manufacturing motors of this type and several machines, in capacities up to 450 h.p., have been installed throughout Australasia. A notable installation is that at the flour mills of Messrs. W. S. Kimpton and Sons, Melbourne, where two 350-h.p. Metropolitan-Vickers motors are driving the mill machinery.* Another large machine is the 320-h.p. auto-synchronous motor supplied by Crompton and Co. to Messrs. Crago and Son Ltd., Sydney. Two 250-h.p. Witton motors, supplied by the British General Electric Co. are running at Broken Hill, and several synchronous induction motors have been manufactured by the Electric Construction Co. for the New Zealand railways. Other installations in the Commonwealth and Dominion might be mentioned, but enough has been said to show that motors of this type are coming into general use for heavy drives.

The synchronous induction motor manufactured by the Metropolitan-Vickers Electrical Co. may be taken as typical, for the main characteristics are the same in all makes. It consists virtually of a slip-ring induction motor provided with an exciter. In a three phase machine the stator and rotor are both wound for three phase supply and, except in special cases, the supply is led to the stator, and the rotor acts as the secondary. The exciter is of the shunt wound type mounted on an extension of the rotor shaft or, in the case of slow speed motors, chain driven. Its function is to supply excitation for the rotor of the motor, which acts as the revolving field when the machine is in normal operation. The external equipment comprises main oil switch,

*See the "Electrical Engineer," Dec. 1921.

three pole change-over switch, liquid starter and exciter field regulator. The connections will be understood from a reference to Fig. 1. The supply is led to the stator through the main oil switch. Leads from the slip rings are taken to the triple pole change-over switch. In one position this switch makes connection to a three phase liquid starter, in the other position it links up with the exciter. It is not possible to obtain balanced excitation in the three phase rotor, but quite satisfactory operation is obtained by paralleling two of the phases so that one phase takes the full current and the others share it.

most efficiently at a leading power factor. From the performance curves shown in Fig. 2 it will be seen that the power factor correcting duty continues from full load right down to no load, in fact, the leading component of current actually increases slightly as the load falls off. It will be seen also from this diagram that the efficiency is about 92 per cent at full load and increases somewhat with overloading. This efficiency curve has been calculated with full account taken of exciter and rheostatic losses. In respect to its overload capacity the synchronous induction motor has an advantage in that

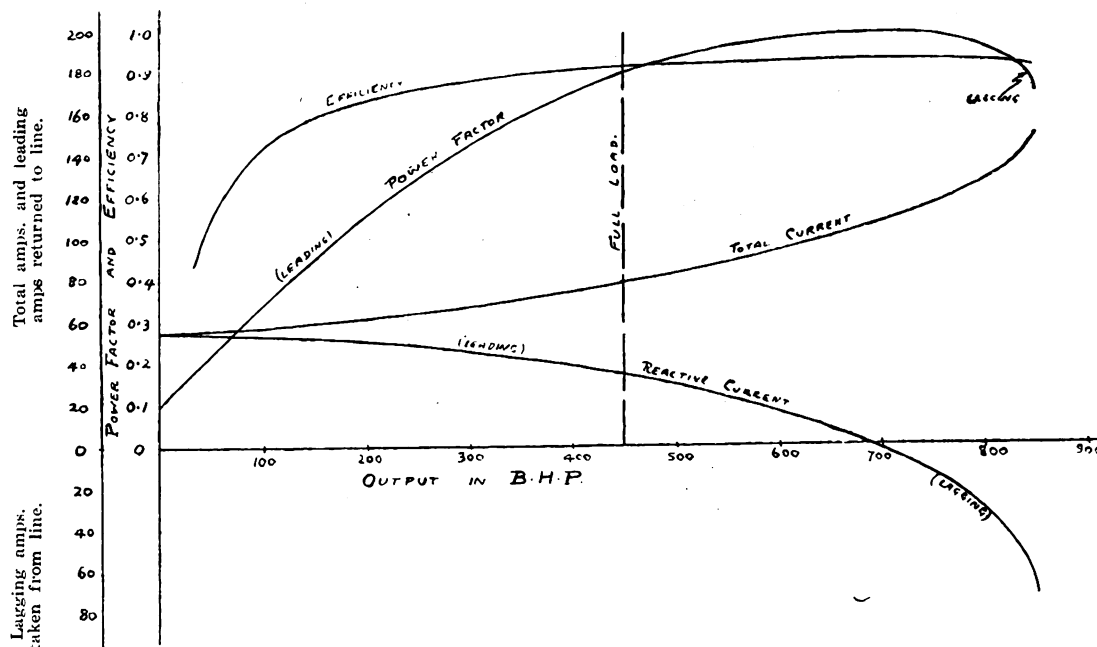


Fig. 2. Performance Curves of 3,000 volt, 450 h.p., 250 r.p.m. Synchronous Induction Motor with Constant Excitation

The starting operation and running up to speed is similar to that for a slip-ring motor. All that is necessary is to close the main switch and cut the resistance out of the rotor circuit by means of the liquid starter. When full speed has been attained the change-over switch is thrown over and the machine pulls into synchronism. The power factor may then be adjusted by means of the exciter field rheostat to give the smallest current consumption for the load carried.

The machine is entirely self synchronising, for its speed as an induction motor is sufficiently close to the synchronous speed to enable it to pull into step at the first cyclic speed variation when the exciter switch is closed. Oscillograph records show that the synchronising operation takes only a fraction of a second and causes no appreciable kick on the line. When running as a synchronous motor the power factor may be readily adjusted through regulation of the exciter field. It is usual to design the machines to run

it it is suddenly overloaded above its pull-out point as a synchronous motor it will continue to run as an induction motor until the load falls again, when it will pull itself back into synchronism. Although this characteristic is useful it is not recommended that advantage be taken of it except in an emergency, as the speed and current will fluctuate fairly heavily while the motor is running under these conditions. Should the load increase to more than $2\frac{1}{2}$ or 3 times full load the machine will fall right out of step and stall just as an induction motor will do. The three phase rotor is of considerable assistance in keeping the motor in step, owing to its damping effect, and this is one reason why it is used in preference to a single phase rotor, in spite of the fact that the heating with the d.c. excitation is somewhat uneven.

The starting characteristics of the synchronous induction motor are generally similar to those of the slip-ring induction motor. It will start against full load torque with a current of from

$1\frac{1}{4}$ to $1\frac{1}{2}$ times full load current, depending upon the power factor for which the machine is designed. With a correspondingly higher current consumption, and with a suitable starter, it will start from rest with a torque of from 2 to $2\frac{1}{2}$ times full load, while in every case it will synchronise against loads of $1\frac{1}{2}$ times full load torque. The maximum overload to which the

motor may be subjected is limited by the pull-out torque, which in standard machines is not less than 1.7 times full load torque. The standard overload ratings are 25 per cent for two hours and 50 per cent for one minute. Synchronous induction motors are now being built in capacities from 50 to 5,000 h.p. and are designed for supply pressures up to 11,000 volts.

New Steam-Electric Station at Cowra, N.S.W.

A new electric supply station has been recently put into operation by the municipal council of Cowra, N.S.W. The plant was designed by, and erected under the superintendence of the council's consulting engineer, Mr. W. Corin, M.Inst.C.E., M.I.E.E., and, contrary to practice with the majority of modern country town supply plants, the generators are steam driven. The consulting engineer has furnished a description of the plant and undertaking, together with a brief discussion of certain of the factors that influenced the design.

Historical

In 1922, Mr. Corin, then chief electrical engineer to the public works department of New South Wales, reported on an electric supply scheme for Cowra, as the result of a request from the council to the minister for works. He pointed out that in three respects Cowra had exceptional opportunities: (1) The power demand was well above the average for a country town of its size; (2) The situation of the town is in the midst of a prosperous community, so that a power station could be laid down with the idea of it becoming the central station for a large district with a radius of at least 30 miles; (3) An excellent site was available near the town, on the bank of a river that could provide ample cooling water, and with a railway close by. From consideration of the ultimate size to which the station might be expected to grow, steam and not suction gas or oil was adjudged to be the correct motive power to be used.

When the scheme described in the report was submitted to the ratepayers it did not at first receive sufficient support to enable it to be proceeded with. A year later, however, the railway commissioners decided to construct a new up-to-date round house at Cowra and to replace an old and somewhat extravagant pumping plant for locomotive supplies by a new pumping station. Negotiations with the municipal council for electric supply were opened, with the result that the commissioners entered into a contract with the council to take a minimum of 60,000 units per annum for ten years at 5d.

per unit, provided that the supply was made available by January 1, 1924. This agreement was concluded in August, 1923, which left little time in which to install the necessary plant. However, two second-hand generating sets, which had done duty at the Hawkesbury agricultural college, were purchased from the department of agriculture and placed in the municipal pumping station. Steam from the boilers supplying the pumps was used for driving the sets. The necessary short transmission main from the pumping station to the railway was put in hand, and at the same time a small part of the town was reticulated. The railway authorities not being ready by January 1, 1924, by mutual arrangement the date was postponed until February 18, when the current was turned on.

At about this time Mr. Corin resigned his position with the public works department, and the Cowra municipal council engaged him as its consulting engineer and directed him to proceed with the larger scheme which he had recommended. This latter is the undertaking which has just been brought into operation.

Description of Undertaking

The power station is situated on the right bank of the Lachlan river, between the river and the Canowindra railway line, about a quarter of a mile beyond the West Cowra station. The building is constructed of a steel framework, supplied by Messrs James Hurl and Co., with reinforced concrete slabs $1\frac{1}{2}$ in. thick fitted into grooves provided by channels in the steel structure. Each slab is made with a depression along the top edge and a corresponding projection along the lower edge. When constructing a building with this material a thin layer of cement grout is laid in the concave depression; into this the projecting lower edge of the next slab above fits making a tight joint. The making and fixing of the slabs was carried out by day labor by the council's staff. The roof is of corrugated asbestolite, and was supplied and fixed by James Hardie and Co.

The boiler house plant includes two Babcock and Wilcox boilers, each of 1,218 sq. ft. heating surface, working at 200 lb. per sq. in., with

integral superheaters giving a superheat of 120 deg. F. The boilers are fired by chain grate stokers designed for balanced draft, but at present arranged to operate on natural draft, the chimney being of sufficient capacity for both boilers working thus together when supplying steam for the generating sets running on overload non-condensing. The design of the flues and chimney base allows for the addition of an economiser, and to counteract the increased friction that would be caused thereby, provision is made at the chimney base for the addition of an induced draught fan. Thus not only may the evaporation of the existing boilers be largely

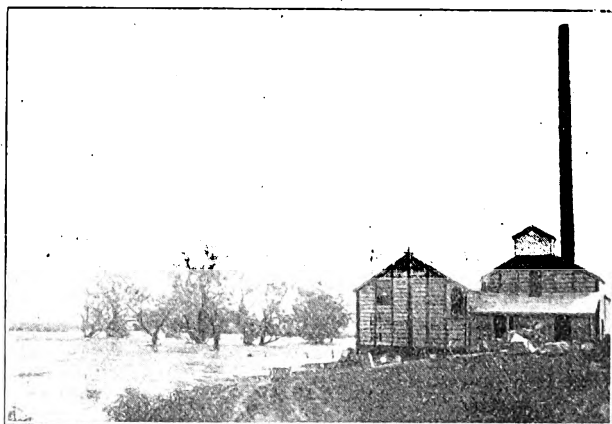


Fig. 1. Electric Power Station at Cowra, N.S.W.

increased by taking advantage of the balanced draught feature, but the boiler capacity may be doubled and the total steaming capacity considerably more than doubled using the existing chimney.

An automatic Lassen and Hjort water softener is provided, the feed water being heated in the softener by the exhaust steam from the Worthington-Simpson feed pumps passing through a steam coil, the discharge from which is led to the blow-down tank. The feed water is further heated by the steam from the condenser ejectors being condensed in a coil and mixed with the feed. The whole of the boiler house plant was supplied by Babcock and Wilcox Ltd., in whose contract were included Lea coal meters for the boilers, a Beck water meter, a steam flow meter and a Duplex-Mono recorder.

The generating plant consists of two Browett-Lindley steam engines, with automatic variable expansion gear, each direct coupled to a 150-kw. alternator generating at 2,300 volts three phase. These sets were supplied by Messrs Crompton and Co. Ltd. The engines exhaust to a double steam jet ejector condenser, built by Briton Ltd. under the patents of the Contraflo Co. The electrical energy is stepped down at the power station to 415/240 volts for the auxiliaries and one distribution circuit, while a transmission

line $1\frac{1}{2}$ miles in length conveys high voltage energy to a substation supplying the railway department and the greater portion of the town.

The substation is provided with four single phase 50 kv.a. transformers (one being spare), supplied by Messrs. Siemens Bros. From the substation, feeders run to several feeding points where connection is made with the distributors through distributing boxes provided with fuses each of which serves a distributing section. Owing to the municipal council having a long term contract with the Gas Co. for street lighting, the electrical street lighting is confined to the main street, with two lamps each, one on each side of the main street, in the principal cross streets.

Factors Influencing the Location of the Power Station

The power station is situated at a point where a rocky bar extends across the river and there is a deep bathing hole where there is always at least from 6 to 7 ft. of water close inshore. Referring all heights to sea level, the rail level opposite the power station is at 960 ft. whilst the lowest summer level of the river is about 906 ft. The highest recorded flood level (in 1916) at this point is 949 ft. 6 in., but in 1870 the flood was probably 2 ft. higher. The power station floor is placed at 950 ft. A flood wall with top at 954 ft. provided with one door only, closed by bulkhead in time of flood, is built all round the power station, but even if a flood rose higher than 954 ft. means have been provided whereby the water can be kept out. A higher flood than that of 1870 is, however, not anticipated as the country on the farther side of the river affords a good getaway for the water when once 945 ft. has been reached. The illustration, Fig. 1, shows the station under flood conditions, when the water rose to 947.3 ft.

Apart from the question of flood level the final location of the power station was influenced by two factors: delivery of coal, and the position of the pump for condensing water. The position was chosen so that the only man-handling the coal receives is in shovelling it from the railway trucks to a small skip on a self-acting inclined tramway by which it is delivered direct into bunkers sufficient for a fortnight's supply. Thence it is raised by a conveyor to a small hopper-bunker above the boilers whence it is fed by gravity to the automatic stokers.

The condensing water having to be raised from the level of the river to the power station, the existence of a 45-ft. drop back to the river under normal low-water summer conditions suggested at once the use of a barometric condenser, particularly as the town water is of fair quality for boiler use and easily purified. The injection pump, Fig. 2, has been placed 15 ft. above the normal summer level of the river.

It is provided with a cover which, when floods are expected, is bolted on and made air and water-tight. Two pipes lead from the power station to the pump, one to supply air under pressure and the other containing the cables connecting the motor and also conveying air back to the power station. The latter is furnished with an adjustable relief valve which can be screwed down to correspond with the head of water over the circulating pump. The air thus fulfils two functions: viz., keeping the water out during floods and acting as a cooling medium for the pump motor. The condenser is furnished with an extraction pump which must necessarily be used when the river is high. Under normal summer conditions, however, the vertical height from the river level to the condenser, about 45 ft., is sufficiently in excess of the barometric height to overcome frictional losses, and the water may be by-passed to the river without using the extraction pump. Even when the river is up a few feet this is still possible with a light load on the generators.

Financial

As regards the cost of the work, the original estimate covered only two 120-kw. sets without any superfluous machinery and amounted to £23,000, the limit of the council's borrowing power at that time. With the addition of the railway load and an evident large and growing demand for light and power, it was decided to put in two 150-kw. sets and construct the building large enough for a third set of two or three times the capacity of the other two. Further additional expenditure was brought about by the installation of larger boilers and the provision of extra boiler house equipment, including conveyor and measuring instruments. In addition, about £500 worth of reticulation extensions was determined upon. Altogether these additions involved an increased expenditure of about £4,750. The temporary generating plant which is now for sale cost nearly £2,000, and the council having embarked on the private wiring business, some additional capital was necessary on this account. Consequently a further loan of £7,000 was arranged.

Tariff

A one-meter, two part tariff has been adopted for domestic supply. Under this the first $2\frac{1}{2}$ units per 100 sq. ft. of floor area per quarter are charged at 9.9d. per unit, and each additional unit at 1.8d. For continuous hot water service, 1.5d. per unit is charged. For industrial power the charges are 4.5d. per unit up to 160 units per quarter per b.h.p., and 1.8d. per unit for all in excess. For industrial heating the charges are similarly 4.5d. and 1.8d. the corresponding limit being placed at 200 units per quarter per kw. No meter or service charge will be made provided that a minimum number of units have

been used. This number if not used must nevertheless be paid for. The minimum is calculated as regards the domestic tariff at the rate of three quarters of a unit per quarter per 100 sq. ft. of area, for industrial lighting and heating at the rate of 40 units per quarter per kw., and for power at the rate of 32 units per quarter per b.h.p.

The economy of the station should compare favorably with that of any other in the state.

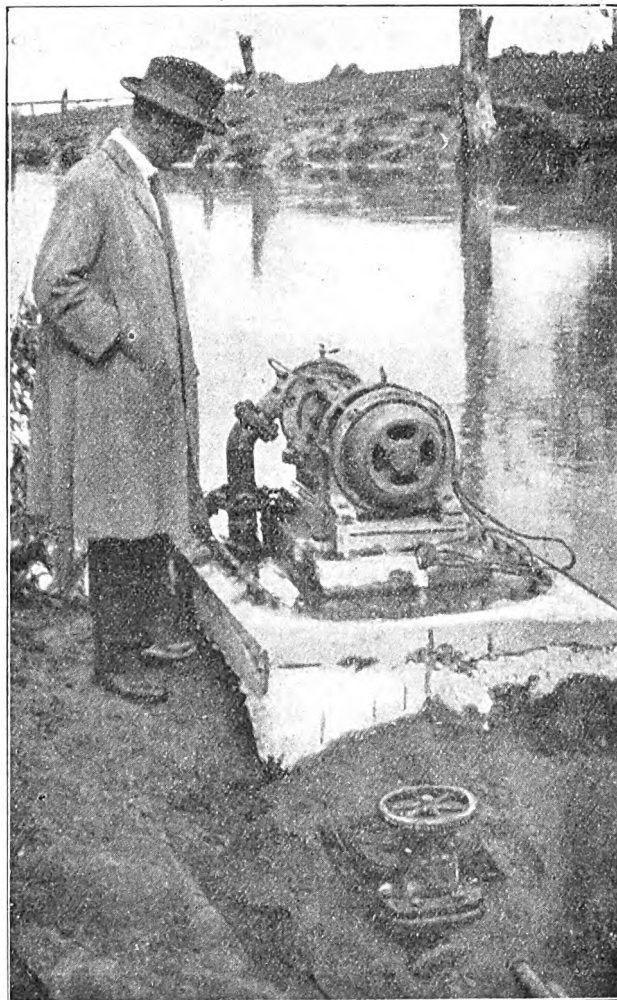


Fig. 2. Condensing Water Pump Set.

It is expected that the early future the mains will be extended into the adjacent shire so that the station may fulfil its proper functions as the source of power supply for the surrounding district.

During the greater part of the construction, Mr. L. Ferris, who was the first municipal electrical engineer, acted as inspecting engineer in respect of the contracts and supervising engineer for the day labor works, which included the reticulation. Mr. Ferris having been recently appointed to Albury, Mr. Austin Diamond has succeeded him as municipal electrical engineer.

The Motor Converter for Automatic Substations

For the conversion of electrical energy from alternating to direct current there are three types of rotating machine which may be employed, the motor generator—the a.c. end of which may be either of the induction or synchronous type—the rotary converter and the motor converter. The essential differences between these types are that in the first there is mechanical connection only between the a.c. and d.c. ends, in the second the a.c. and d.c. portions are combined to form a single machine, and in the third there are two machines interconnected both mechanically and electrically. The motor converter may be classified as a combination of motor generator and rotary converter. Before proceeding to a discussion of the particular merits of the machine it will be well to give a brief description of its construction and principle of operation. Messrs. Bruce Peebles and Co. Ltd., of Edinburgh, Scotland, are specialising on the manufacture of motor converters under the La Cour patents, and the following is a description of a typical machine as built by this firm.

It is its essentials the motor converter consists of an ordinary wound rotor induction motor direct coupled to a d.c. machine, the rotor winding of the a.c. end and the armature winding of the d.c. end being electrically interconnected. The a.c. and d.c. ends need not necessarily have the same number of poles, but the simplest case occurs when they have; therefore this case will be used for purposes of description. Fig. 1 is the diagram of connections for a machine with bipolar a.c. and d.c. ends. With such a machine the combined rotor and armature rotates at a speed corresponding to half the primary frequency, i.e., with 50 per cent slip. This speed is maintained by reason of interaction which occurs between the field of the d.c. machine and a rotating field induced in the rotor-armature. As the rotor is running with 50 per cent slip it necessarily follows that the rotating field in the a.c. stator rotates relatively to the rotor, at a speed corresponding to half the frequency of the supply circuit. Thus there is induced in the rotor windings a series of e.m.f.'s. which have also half the frequency of the supply circuit. Naturally, in order that the e.m.f.'s. induced in the rotor and armature windings shall balance each other, the interconnections must be so arranged that the rotating field set up by the motor currents, when flowing through the armature, revolves in the opposite direction to that of the shaft. That is to say, this rotating field is motionless in relation to the d.c. field so long as the speed keeps constant, and it is

the interaction between these two fields that holds the speed at one half of that which corresponds to the primary frequency. Even when the numbers of poles on the a.c. and d.c. ends differ it is possible—by winding the rotor and armature with suitable numbers of turns, and by correct interconnection—to obtain a similar effect, though the rotor speed will not necessarily be half of that due to the frequency. The interaction between the rotating and d.c. fields gives rise to a very large synchronising force which holds the machine at speed even under very unfavorable conditions. The number of poles at the d.c. end is, of course, arranged so that the frequency of the currents induced in the armature winding is the same as the frequency of the rotor currents.

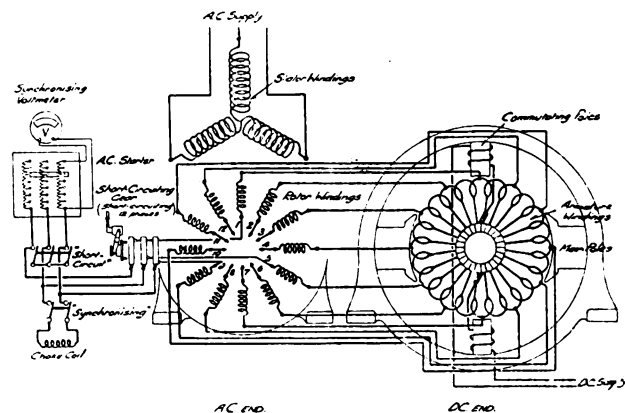


Fig. 1. Diagram of Connections of Self-Synchronising Peebles Motor Converter.

As the rotor rotates at a speed corresponding to half the frequency of the supply circuit, only half of the energy supplied to the a.c. end is converted into mechanical energy and transmitted by means of the shaft to the d.c. end. The other half, by the transformer action of the stator and rotor, is transferred through the rotor winding to the armature winding in the form of electrical energy. Thus the a.c. end operates half as a motor and half as a transformer, while the d.c. end operates half as a direct current generator and half as a rotary converter. As the size of the a.c. end depends on the speed of the rotating field and not on that of the rotor, it is, theoretically, only half as large as a motor which is required to convert the whole of the energy led into it into mechanical energy, and which runs at the motor converter speed. The d.c. end, running at a speed corresponding to half the primary frequency—which, incidentally, is advantageous

as regards commutation—is of smaller proportions than an ordinary continuous current generator or rotary converter for the same output, frequency and speed.

When the number of poles at the d.c. end is different from that at the a.c. end the motor converter speed will be inversely proportional to the sum of the number of poles.

Thus—

$$n = \frac{60f}{Pa + Pd}$$

Where— n = Revolutions per min.

f = Frequency of supply circuit.

Pa = Number of pairs of poles at a.c. end.

Pd = Number of pairs of poles at d.c. end.

If $Pa + Pd$ be expressed as P then the a.c. end converts Pa/P of the total energy supplied into mechanical energy, while Pd/P of the total energy supplied is transferred from the rotor winding through the interconnections to the armature of the d.c. end. Consequently the d.c. end deals with Pd/P of the total energy supplied as a rotary converter, and with Pa/P as an ordinary d.c. generator.

Motor converters can be arranged for starting up either from the a.c. or the d.c. end, the former being the prevalent practice. Starting in either way is, however, quite a simple process. In starting from the a.c. end, alternating current at supply voltage is thrown direct on the stator windings, currents being induced in the windings of the rotor which immediately starts to rotate. The a.c. supply, whether high or low tension, is entirely confined to the stator winding, and all rotating parts carry low voltages only. Usually only three of the twelve phase windings on the rotor are used at starting; one end of each of the three is connected through the slip rings to a fixed external non-inductive resistance, as shown in the diagram. The ends of the remaining nine phases are carried to a similar number of short-circuiting contacts, and as each slip ring is also connected to a short-circuiting contact, there are twelve of these in all. From the foregoing it will be seen that the motor converter is started up as an ordinary slip ring induction motor. As the speed increases the d.c. end, which is disconnected from the busbars and is self-exciting, builds up its field. When the machine approaches its synchronous speed, the e.m.f.'s. induced in the rotor and armature will alternatively be in opposition and in conjunction, consequently the current flowing in the starting resistance will vary considerably, causing the needle of the synchronising voltmeter, which is connected across the resistance to oscillate. The oscillations, however, will gradually become slower until it is possible

to close the switch for short circuiting the resistance, when the needle is falling and near the zero end of the scale. Immediately after this the short circuiting device is also closed, bringing all twelve rotor phases into use, and creating the star point. In practice it is found necessary to insert resistance into the d.c. shunt circuit to enable the machine to be brought up to speed without taking excessive current from the supply mains. The current required for starting is usually about 30 per cent of full load current. For starting from the d.c. end an ordinary direct current motor starter is used, in conjunction with some standard form of synchronising gear for the a.c. end.

For a self-synchronising machine, such as that for which connections are shown in the diagram, the only addition to equipment is a small choke coil with an isolating switch. A machine thus equipped, when started up, will pull into synchronism automatically. Similar performance is obtainable with a rotary converter, but the equipment for attaining the desired characteristic is much more complicated.

Peebles motor converters are built with three bearings, and the leads between rotor and armature are carried through the centre journal. The slip rings are placed close to the rotor windings and are of small dimensions, their function being merely to start the machine, and slip ring short-circuiting gear is provided. In the standard design the d.c. end is fitted with commutating poles, and will carry 100 per cent overload for short periods without injurious sparking of the commutator, and with fixed brush position.

Motor converters are suitable for operation in any service. They may be built to supply direct current energy for lighting and power purposes, for railways and tramways, or for three-wire balancing. They may also be used for power factor correction. For lighting and power service they may be either shunt or compound wound at the d.c. end. Shunt machines have a voltage drop of about five per cent from no load to full load without alteration of the regulator. The power factor at full load and maximum voltage is high, and machines may be designed for a leading power factor. For traction service motor converters are usually compound wound. They are particularly reliable under the heavy overload conditions obtaining in such service. The design is usually worked out so that the power factor is unity at three quarter load, which means that at all higher loads the power factor is leading. For a combined system, where d.c. energy is required sometimes at 440-480 volts for power and sometimes at 500-550 volts for traction, the motor converter is peculiarly adaptable, as the voltage may readily be varied in a manner similar to that

employed for variable voltage d.c. generators. A voltage range up to 40 per cent may be obtained without the addition of an induction regulator, booster, or other complication.

The great expansion of electric traction systems during the last few years has been, to a large extent, rendered possible by the increased economy of operation brought about by advances in the design of equipment. One of the latest contributions in the direction of reducing operating costs has been made by the introduction of automatic substation equipment. In this field the motor converter is now coming into prominence, its inherent reliability giving it strong recommendation to consideration. Messrs. Bruce Peebles have co-operated with Messrs. A.

the control station, and means are provided for starting up, shutting down, resetting the lock out mechanism, locking out the plant or interrupting the automatic shutting down operations from the distant centre if required. The type C station is fully automatic, but has the further feature of fully remote control from a distant station through two or more pilot leads. The equipment is similar to that of station types A and B, but has additional features which allow of interruption of the automatic functions and the placing of particular operations under the control of the engineer at the distant station. Amongst the additional features are: control of voltage, control of machine circuit breakers and feeder circuit breakers, reading of machine and

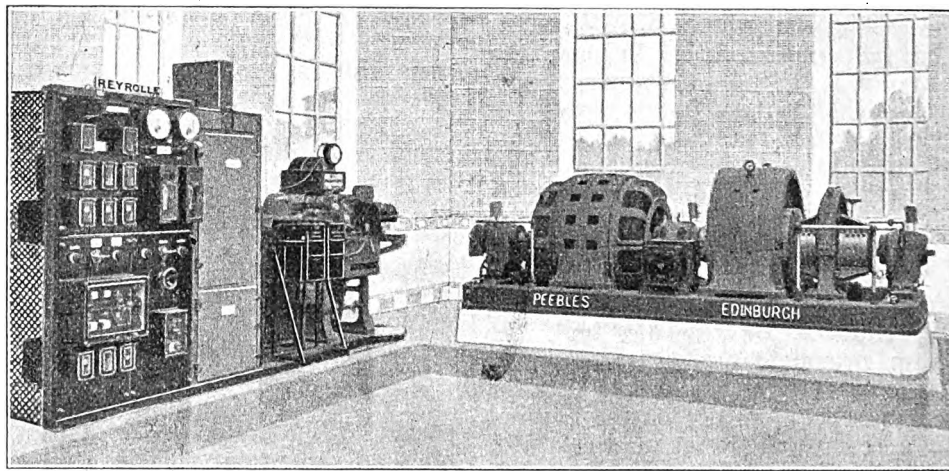


Fig. 2. Typical Traction Substation, with Peebles-Reyrolle Motor Converter Equipment.

Reyrolle and Co. Ltd., Hebburn-on-Tyne, England, in standardising complete equipments of motor converting machinery and automatic switchgear for substation operation. As the simplicity and reliability of the motor converter renders it eminently suitable for unattended operation, so the ruggedness and sound design of the Reyrolle metalclad switchgear makes it equally appropriate for use under the exacting conditions of automatic traction service.

Peebles-Reyrolle automatic equipments are classified into three types. Type A is a fully automatic equipment which operates as an individual station on a network. This station starts up and shuts down according to the varying conditions of the portion of the network with which it is paralleled. The station will lock out on fault, and visible or audible means may be employed in or near the station to indicate whether it is working or off due to no demand or lock out conditions. The type B station is fully automatic, similar to type A, but has the additional feature of semi-remote control from a distant station through two pilot leads. In this the visible or audible alarm is transferred to

busbar voltages and of machine and station load, and the reporting of abnormal operations. When under inspection all automatic equipments may be operated semi-automatically or entirely manually.

The station equipments are built as units, i.e., with a single motor converter. Starting up is brought about by the demand for power, but in order to guard against starts due to momentary voltage drops, the condition of low voltage must persist for a definite period, variable between five and 30 seconds. In the case of the plant failing to come on to load after running up, it is shut down and, after a few seconds, makes a second attempt. If this fail a third attempt is made, and in the event of this also failing the station is shut down and locked out, and the alarm circuit is made. This feature provides the flexibility essential for meeting emergency conditions. When the machine comes up to speed under normal conditions it is automatically synchronised and connected to the d.c. busbars. The usual time taken by the plant in getting on load is about 75 seconds. Shutting down is effected through the agency

of a relay which operates when the load falls below a predetermined value. The whole operation takes about two seconds. Protection is provided against overloading of bearings, overheating of machine, overspeed, and a.c. overload and earth leakage. In the case of operation of any of the devices protecting against these eventualities, the plant will be shut down and locked out until deliberately put again into commission. There is also a provision against single phase running of the converter motor. Protection against overload on the d.c. side is provided by a high speed circuit breaker which renders the plant immune from danger of flashover.

The advantages of motor converters over rotary converters are more apparent at the higher commercial a.c. frequencies. There are, however, many points on which the motor converter will demonstrate its superiority at all frequencies. The first great advantage is one which the motor converter shares with the motor generator: that no transformer is required, the h.t. a.c. energy being impressed directly on the motor stator. One result of this is a saving in floor space, while another advantage is the elimination of the leads between the transformer and the machine, with their inevitable losses. The second principal group of advantages arises from the comparatively low speed of revolution of the motor converter, which gives the machine low frequency characteristics. The number of poles at the d.c. end is considerably less than that corresponding to the supply frequency and therefore a reasonable distance between brush spindles is obtainable without having an excessively large commutator. This considerably reduces the possibility of flashover. The low speed and comparatively small diameter of commutator makes for good commutation and considerably reduces wear on brushes and commutator, at the same time reducing the noise in operation.

The inherent ability of the machine to keep in synchronism under trying conditions is another strong point. Cases have been known where the supply voltage dropped to 50 per cent of its normal value, but the motor converter still remained in step. Again, the motor converter is not liable to reverse its polarity at starting up, or on short circuit, a contingency which sometimes gives trouble with the rotary converter. The simplicity of arrangements for voltage variation is another point in favor of the motor converter.

Apart from all the foregoing the motor converter has a strong advantage over the rotary for automatic installation, by reason of the greater simplicity of the switching arrangements for the former machine. Not only is the switch-gear less costly, but it takes up less space and, most important of all, there is less apparatus

likely to get out of order. The efficiency of the machine is about the same as that of a rotary converter of similar capacity, being slightly less at full load, but equal at light loads. The initial price of the motor converter is slightly higher than that of a rotary converter for similar service.

ELECTRICAL MANUFACTURING IN GERMANY

The firm of Siemens-Schuckert has been somewhat before the public lately in connection with the hydroelectric development of the river Shannon in Ireland. It is interesting to note that this company is one of several which owe their existence to the pioneering work of Werner Siemens, who commenced operations for the manufacture of the needle telegraph, which he had invented, in 1847. Siemens-Schuckert engages in all heavy electrical manufactures, and the firms allied with the larger company include Siemens and Halske, which specialises in telegraphy and telephony, instruments, etc., and Siemens Bros., manufacturing carbon products. Siemens-Schuckert has works at Nuremberg, but the principal activities of all the Siemens companies are centred near Berlin, where an electro-technical town housing 50,000 employees of the various factories has sprung up.

ATTRACTIVE MOTOR BUSES.

Melbourne-Suburban Buses Ltd. has recently commenced operations on a new route from Box Hill through Camberwell and Hawthorn, and feeding the cable tramway to the city at Victoria Bridge, Richmond. The buses which the company is using are designed to give a maximum of comfort to passengers, and are certainly very attractive. The Denby chassis is used, with pneumatic tyres and shock absorbers. It is specially designed to give comfortable riding on medium quality roads. The bodies are built by A. Houchkiss and Co. Pty. Ltd., Hawthorn, and provide luxurious accommodation for 28 passengers, including smokers. The loading line is low, so that the patrons do not have a considerable climb in getting in. The ventilation is excellent, and the lighting for night running brilliant. The company realises that its business is to sell rides, and the more attractive the commodity the better will be the patronage.

The Victorian government is experiencing some difficulty in the appointment of an expert to enquire into the undertakings of the electricity commission. It is probable that an appointment from outside Australia will have to be made.

The Future of Railway Electrification*

It is generally recognised that adequate and efficient rail transportation is the prime necessity of modern civilisation. It is, therefore, of the utmost importance that the railroads of any country should keep pace with the requirements of its future growth. This can only be done by the adoption and proper utilisation of the best and most modern machinery and methods. Electrification is the outstanding modern development which will improve the efficiency of railroad operation.

Electric locomotives require much less servicing than steam locomotives, they will work as efficiently in tunnels, subways, sheds or other enclosed places as in the open, and will permit of a much quicker and more efficient handling of cars in terminals than is possible with steam. Also, if the property on which the switching and terminal tracks are located is depressed, it can be used for buildings almost as well as if the terminal did not exist. In any event, the absence of steam, smoke, gases and noise, as well as other objectionable features incident to steam operation, permit the location of such terminals near high class residence or business property. Again, terminals and yards in large cities or congested places, can be worked so much more efficiently by electric operation that much space can be saved and valuable real estate reclaimed for other uses. Suburban traffic also can not only be more efficiently handled by electric operation but the service rendered becomes much more agreeable to the railway patrons, and can generally be considerably expanded with existing track facilities.

In the field of main line and heavy long-distance traffic, while the amount of work actually done during the past ten years has not kept pace with electric power development in the lighting and industrial fields, steady and continuous technical progress has been made. No system of electrification has been found impossible of successful results. The particular system to be adopted in any special case is a matter of engineering study and determination but when decided upon, there is more than one thoroughly competent manufacturing company ready to bid on and execute the work.

It is interesting to review briefly the railway electrification work already done in the world. In June, 1924, there were built or building a total of 2,351 electric locomotives of all kinds with an aggregate h.p. capacity of 4,259,148; of this number 1,446 locomotives operated on alternating current and 905 on direct current, the aggregate h.p. being 2,780,692 and 1,478,456 respectively.

Of these locomotives, 465 of a h.p. capacity of 862,596 were on the railroads of the United States, but this number was exceeded by the Italian railways, which had 504 locomotives of a capacity of 1,209,736 h.p. No other country has as many, the next being France with 366 locomotives of 384,460 h.p. capacity, Germany with 304 locomotives of 518,841 h.p., and Switzerland with 214 locomotives of 384,152 h.p.

A recent engineering achievement is the development of an electric locomotive which, in connection with a high tension a.c. contact wire, permits the choice on the locomotive of either single phase or three phase a.c., or of d.c. motors of any voltage desired. Thus a very long step has been taken toward a standard, or at least a uniform system of contact wire which will enable those railroads using it to freely interchange traffic with locomotives of several different kinds. The rapid development also of the system of interconnecting electric power plants is working to the advantage of the railroads, as this plan makes available an abundant supply of reliable electric power at many different points, and will enable a railroad to be electrified without the necessity for the very large investment for power house and machinery otherwise required.

Again, with electric power, the trunk line railroads can concentrate much larger amounts of power in each train than is possible with steam locomotives on account of the limitation of the steam locomotive boilers. This concentration of power in main line traffic means larger trains and higher speed, or both, if necessity requires, and almost without limitation.

There is ample evidence of the value of the electric locomotive in switching service. In a recent article by Mr. Herbert Quick† it is stated that the New York, New Haven and Hartford railroad recently put into service 16 electric switchers, operating in the crowded terminals of New York city and vicinity and through the dense industrial belt of New England, which faces a most acute terminal crisis whenever business is good. These electric switchers on many occasions have run 24 hours a day for 30 days without interruption. So efficient is their service that six electric switchers take the place of ten steam switch engines.

The reliability of electric service is exemplified in another statement in the same article: On the Philadelphia, Paoli and Chestnut Hill electrified division of the Pennsylvania railroad the schedule is made with such regularity as to

*Extract from paper by E. M. Herr, Westinghouse Electric and Mfg. Co., U.S.A.

†Annals of the American Academy of Political and Social Science.

record 10,000 train miles to every detention. This is substantiated also by the record of the 33 electric locomotives that have handled passenger traffic in and out of the Pennsylvania Terminal at New York city for the past fifteen years. They have made 11,456 miles for every minute of detention, including electrical, mechanical and man facilities.

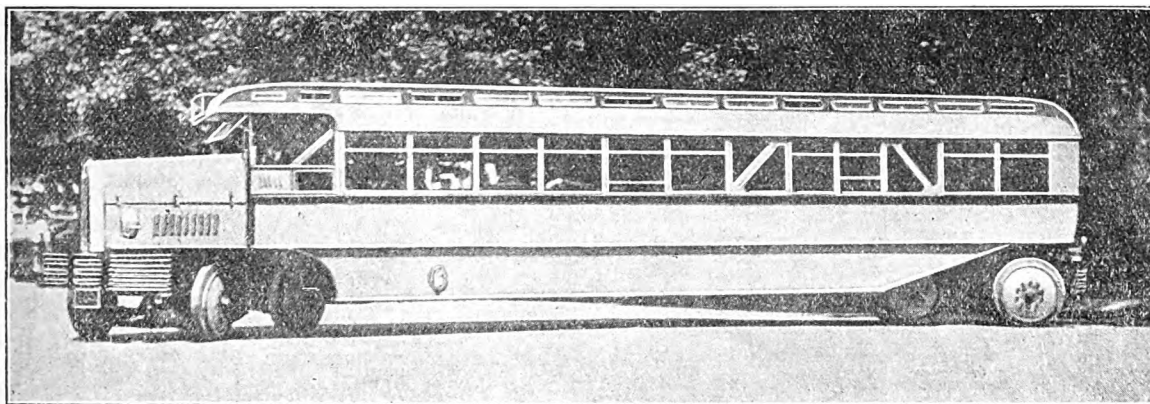
Electric railways have been in successful operation for upward of twenty years, during which time the cost of production of electricity has steadily decreased and the reliability with which

it can be handled and its availability to railroads has constantly been improved. Here, therefore, is a means by which the capacity of the railroad can be increased with a minimum of expenditure, and at the same time its efficiency very materially improved. It is on the heavily loaded lines that the question of electrification becomes important. Any broad programme, of course, involves a large expenditure, but with careful discrimination expenditure on electrification will return results that no other investment in plant can show.

Eight-Wheel Petrol Electric Bus

A petrol electric bus of a type constituting a new departure in heavy road vehicles has been recently demonstrated and tested in the United States. The vehicle was built by the Versare Corporation of Albany, N.Y., and equipped electrically by the Westinghouse Electric and Manufacturing Co. It has eight wheels, arranged

the usual position, and the generator is beside the driver's seat. Electrical energy is supplied to two traction motors, one on each bogie truck, each rated at 28 h.p. at 175 volts. Each motor is suspended between the axles of the bogie, and is mounted on trunnions carried in links suspended from the truck frame. The drive is



Versare Petrol Electric Bogie Bus.

on two bogie trucks, and is built on a frame similar in style to that of a tram car instead of on a chassis of conventional type. The bus is designed to seat 44 passengers, and take 52 standing. It is 38 ft. long overall, and weighs eight tons without load. Its most remarkable feature is that it can turn on a circle of only 43 ft. diameter. This is made possible by a special patented steering system, which is also responsible for the practicability of employing the eight-wheel arrangement. The increased number of wheels, as compared with the ordinary vehicle, makes possible very much heavier loading, without exceeding a specified tire load.

The bus is equipped with a 110 h.p. six cylinder engine, which drives a 40 kw., 1,200 r.p.m., d.c. generator through a flexible coupling. The engine is mounted under a bonnet hood in

transmitted to the rear pair of wheels only on each truck, through a universal joint to a standard Eaton axle, with gear reduction of 10.5 to 1. The wheels are 30 in. diameter, equipped with cushion tires. The trucks are placed at 29 ft. centres, and the wheel base of each is 54 in., and the track 69 in. Both front and rear trucks are swivelling, being operated by the steering system, so that the wheels of the rear truck follow almost identically on the tracks of those of the front truck. Each truck turns about a king pin placed slightly to the rear of the front axle of each bogie. The drive controls the front wheels of the front bogie in much the same manner as with an ordinary self-propelled vehicle. The pull of these wheels, when turned, causes the whole bogie to turn in the desired direction, in a similar manner to the

action of a four-wheel vehicle. The front wheels of the rear bogie are operated automatically by the turning movement of the body of the vehicle, and the whole bogie follows them, with action similar to that of the front bogie.

The normal operating speed of the bus is 25 m.p.h., and the maximum speed 30 m.p.h. The generator is connected to the motors through a master controller operated by a lever at the left of the driver. An electric braking system is used for holding the vehicle at a constant balancing speed on grades, and there is also a Westinghouse air brake system and a

hand brake. In operation the master controller is seldom used except in starting, but speed control is effected by means of the engine throttle. There is a provision by means of which electric braking may be effected without throwing the master controller into the off position. This vehicle has proved under test to be remarkably easy to handle. There is no reason to doubt its reliability, as all the more unusual components have been thoroughly tried out in exhaustive experiments before incorporation in the assembly.

Government Electric Supply Undertakings in N.Z.

The report on the activities of the New Zealand public works department for the year ended Mar. 31, 1925, gives a very complete summary of the advances that are being made by the government in the development of the extensive hydroelectric resources of the Dominion. Details of the operations of the existing government electrical generating undertakings are given, and mention is made of works now in hand or about to be commenced in order to make provision for the requirements of the immediate future.

In the various hydroelectric schemes a total of 51,000 h.p. has been developed up to the present time. The total capital cost of these works and of the transmission lines to make the power available where required is £2,195,660, or about £45 per h.p. Two of the schemes are in full operation and have earned profits during the year.

Lake Coleridge.

At the Lake Coleridge station the financial results were as follow:—Gross revenue, £92,163; working expenses, £23,270; interest, £47,780; depreciation, £15,679; net profit, £5,434. This profit has been utilised in reducing the accumulated deficiency, which now stands at £17,738. The plant has operated very satisfactorily, although it has had to carry heavy overloads on several occasions. The plant rating is 12,000 kw., but the maximum demand was 13,180 kw. Since the end of the period under review a peak exceeding 14,000 kw. has been successfully carried. During the year two 30 in. diameter siphons were installed to bring additional water over the intake gates and screens, in order to reduce the heavy frictional losses that were occurring on heavy loads. These pipes have greatly assisted the plant in standing up to the demands made upon it. Considerable extensions are now being made, and it is expected that additional generating capacity to the extent of 15,000 kw.

will be available by June, 1926. In addition, the supply is to be extended further afield by the duplication of the present transmission line to Timaru, and the erection of an extension line to Oamaru.

Statistics of the operations of the plant during the last two years are as follow:—

Year ended Mar. 31—		1924	1925
Units output	50,614,955	59,528,216	
Units sold—			
Christchurch city council	21,664,830	25,616,445	
Christchurch tramways ..	7,623,900	7,851,060	
Other bulk supplies ..	14,198,034	17,420,138	
Retail consumers	305,608	399,390	
Maximum load—kw.	10,800	13,180	
Average load—kw.	5,722	6,820	
Average load factor—per cent	53.0	51.8	
Working costs per kw. maximum	£ 1.92	£ 1.76	
Capital charges	5.28	3.63	
Revenue per kw. maximum ..	7.27	6.99	

Waikato System.

At the Horahora plant the year's results were as follow:—Gross revenue, £65,184; working expenses, £14,106; interest, £20,129; depreciation, £9,757; net profit, £21,192. This plant has now paid off all deficiencies, and part of the surplus, therefore has been utilised in paying sinking fund contribution, amounting to £4,138, and the balance carried forward into reserve. During the year two 2,000 kw. generating units were installed, bringing the station capacity up to 10,300 kw. The public works department has an arrangement with the Waihi Grand Junction Gold Co. to use the company's 1,500 kw. steam plant as a standby. In addition, an arrangement has been made to get further power, to the extent of 1,800 kw. for eight hours a day from the new hydroelectric plant of the Tauranga borough council. The total system supplied from Horahora consists of 86 miles of 50,000 volt lines, and 38 miles of 11,000 volt lines belonging to

the department, and 404 miles of 11,000 volt lines, 469 miles of 3,300 volt lines, and 399 miles of 400 volt lines belonging to local authorities. The Waikato system is now in course of rapid expansion to take in a larger area, and give supplies to several important centres.

The principal work in this connection is the Arapuni development. With this are associated numerous transmission lines, which are being built in readiness to provide loading for the station as soon as it is complete. The construction of one main 110,000-volt line has been completed from Hamilton to Auckland, and this will be operated meanwhile from Horahora to give a supply of 2,000 kv.a. to the Auckland power board. The construction is in hand of a 50,000-volt line from Arapuni to Rotorua. When completed this will be operated from Horahora until Arapuni is available. An extension of the Te Awamutu 50,000-volt line is under construction to Hangatiki, to give supply to the Waitomo power board. Surveys are in hand for a 50,000-volt line connecting Waikino and Bombay, across the Hauraki Plains, and also for the additional main 110,000-volt lines between Arapuni and Auckland. A start has been made with the erection of a 50,000-volt line between Waikino and Katikati, to connect the Horahora system with the Tauranga plant at McLaren's Falls.

Operating results of the present system, i.e., the Horahora and Grand Junction plants, for the past two years are as follow:—

Year ended Mar. 31—		
	1924	1925
Units output	45,077,150	45,643,664
Units sold—		
Power boards, etc .. .	11,508,951	17,448,673
Mining companies .. .	27,734,151	22,778,425
Government railways ..	247,613	485,059
Other consumers .. .	424,139	569,002
Maximum load—kw. . . .	7,400	8,300
Load factor—per cent ..	69.6	62.7
	£	£
Working costs per kw. maximum	1.69	1.69
Capital charges	4.28	4.47
Revenue per kw. maximum ..	8.10	7.85

Other Developments.

On the small development at Waikaremoana, which is leased to the Wairoa power board, the capital charges for the year amounted to £5,735 and the revenue to £2,440, giving a loss of £3,295. The Mangahao station only came into partial operation towards the end of the year. The peak load at the end of June had reached 9,080 kw. This station is giving supply to several power boards, and the demand is increasing very rapidly.

The programme of future construction includes various works at all the stations. A second dam is to be constructed at Mangahao to give storage necessary to run the station at full capacity. Plans and specifications for the first stage, 20,000 kw., of the main development at

Waikaremoana will be completed, and, if satisfactory contracts for the sale of power are entered into, a commencement will be made with the construction. The works now under construction and about to be started at an early date will require a capital expenditure of about £1,000,000 per annum for the next few years, but are such that they may reasonably be expected to pay interest and operating costs within a short period after completion.

Distribution of the power generated in the government hydroelectric stations is carried out by power boards and other local authorities. Up to the end of the period under review 39 power boards had been formed, a great many of which had their particular schemes in operation, while others were proceeding with construction works. The area covered by the operations of these bodies is 62,520 sq. miles, or 61 per cent. of the total area of the Dominion, and the population thus served is 776,500, or 59 per cent. of the total population. Several of these boards do not take bulk supplies from the government, but have their own generating stations, either steam or hydroelectric.

Including the government plants there are now 56 electric power stations giving public supplies in the Dominion. The total installed capacity is 81,876 kw., an increase of 15,922 kw. during the year, and the sum of the maximum loads is 68,088 kw. Steam stations account for 47.5 per cent. of the installed capacity, and hydroelectric stations for 46.8 per cent. The number of consumers supplied is 148,699, and the population in the various power supply areas is 930,980, over 70 per cent. of the total population of the Dominion. The maximum demand per head of population in the areas supplied is 0.073 kw., and the units sold per head of population served stand at 214.

MOTOR BUSES IN AUCKLAND

The city council of Auckland, N.Z., is endeavoring to meet bus competition with its tramway system by running its own buses. Ten of these vehicles have been in service for some months and a further 20 are now being put on the roads. Fifteen of the new buses are of a light type, fitted with pneumatic tires and seating 26 passengers. They are operated by one man, the passengers dropping their fares into a specially constructed box as they alight. Nearly all the routes on which these buses operate are of one section only. The vehicles have been found to give good performance in service, having sufficient power for quick acceleration and for satisfactory operation on heavy grades. Owing largely to the bus competition the council anticipates a deficit of over £24,000 on the current year's working.

TARIFF REDUCTIONS IN ADELAIDE.

The Adelaide Electric Supply Co. Ltd., after consideration of the results of its operations for the financial year ended August 31, 1925, has made reductions in the metropolitan supply tariffs as follow:—On all lighting tariffs, $\frac{1}{4}$ d. per unit; on industrial power consumption under tariff D—on the first 500 units per month, $\frac{1}{4}$ d. per unit, and on the consumption between 1,000 and 51,000 units per month, 0.07d. per unit; on industrial power consumption during the hours from 10 p.m. to 8 a.m. under tariff E—on the first 2,500 units per month, 0.21d., and on the next 50,000 units per month, 0.185d.

The total reduction in revenue represented by the alterations in tariffs is about £30,000 per annum. At the end of the previous year reductions totaling £16,000 per annum were made, when the domestic power rate was brought down to $2\frac{1}{4}$ d. per unit and other reductions were made. The policy of the company is to supply at the lowest rates consistent with the maintenance of its usual dividends, and the necessary provision for depreciation. The average rate of dividends and interest paid on the total of the shares and debenture stock issued is approximately 7.2 per cent.

SYDNEY TRAMWAYS.

The tramways operating in the city and suburbs of Sydney are under the control of the railway commissioners. There are several separate systems, most of which operate under electric traction, although in certain outlying districts steam cars are used. On the electric lines the gauge is 4 ft. 8 $\frac{1}{2}$ in., and the cars are operated from a 600-volt trolley wire. The report of the commissioners for the year ended June 30, 1925, shows that on their tramway operations throughout the whole state of New South Wales, including the systems in the Newcastle and Broken Hill districts, a net loss of £102,079 was incurred. The total earnings were £3,619,272, the working expenses £3,174,862, and the interest charges totalled £546,489. On the Sydney and adjacent electric systems the gross earnings totalled £3,331,701, the working expenses were £2,823,510, interest accounted for £462,897, and the net gain was £45,294. In these systems the total single track mileage is 287 $\frac{1}{2}$, and during the year the car mileage totalled 31,238,520, and 314,563,600 passengers were carried.

The tramway earnings have shown a considerable falling-off from those of the previous year,

while at the same time the working expenses have increased. The net result of this is that the operating ratio has advanced from 85.07 per cent to 87.72 per cent. The factors contributing to this state of affairs are the introduction of improved services, with consequently increased car mileage, the falling-off in business resulting from motor bus competition, and additions to working costs due to wages increases. The commissioners state that, "In view of the fact that the tramways are not now paying working expenses and interest, and that recent developments indicate that the position is rapidly growing worse, steps should be taken without further delay to ensure that all future expenditure upon street transportation shall be upon sound economical lines. At the present time vested interests are being rapidly built up, regardless of the fact of the services furnished thereby being already partially or wholly provided by the organisation in which millions of public capital has been sunk. It should also not be overlooked that the tramways, which do not wear out the roads, are relieving the ratepayers of the cost of maintaining the road surface over the whole of the 228 route miles of tram tracks. Furthermore, while such cost of maintenance is very materially increased by road vehicles, no portion of the sums collected from the latter as vehicle taxes is allocated to the tramway revenue. The real requirements of the public must be met, but the duplicating of facilities at present provided by the state is totally destructive of good service, causes dangerous congestion in the streets, and is creating a serious, unnecessary, and increasing financial burden, which must be borne by the public. The disastrous position which has arisen in this way in many large cities can be prevented in Sydney only by establishing a competent authority to control the volume and nature of motor bus services which may have an effect on the transportation provided or contemplated by the state. In the absence of such control there is a lack of reasonable business security for the investment of further capital in extending or improving the state's existing services."

During the past year 12 chains of double track and 74 chains of single track tramways have been laid. Also a length of 13 miles 25 ch. of track has been relaid and 5 miles 9 ch. duplicated. On maintenance work 78,483 tons of road metal were used, and 582,075 sq. yd. of road surface was top-dressed with tar. The rail grinding machine was used on 22 $\frac{1}{4}$ miles of corrugated rails, and 46,748 ft. of rails and 2,624 crossings were electrically built up in situ. In the rolling stock branch steady work was done on car maintenance, and 15 new P class cars, built by contract, were put into service. Mr. W. H. Myers is the chief electrical engineer to the railway commissioners, and Mr. G. R. Cowdery is engineer for tramways.

NEWCASTLE TRAMWAYS.

The tramways at Newcastle, N.S.W., are operated by the railway commissioners. At present the system is in course of change-over from steam to electric traction. There is a total single track length of 52 miles of permanent way of 4 ft. 8½ in. gauge. During the year ended June 30, 1925, the gross earnings of the whole system totalled £219,889. The working expenses amounted to £249,342, and interest accounted for £71,004, resulting in a loss of £100,457. During the period, 1,967,060 tram miles were run and 19,460,780 passengers carried. In connection with the electrification there has been steady progress during the year. Eight and a half miles of overhead trolley wire, six miles of 2,200-volt lines, two miles of 11,000-volt lines, and eight miles 60 ch. of low tension overhead cables have been erected. Two substations have been opened, each containing two 1,000 kw. rotary converters, one station being automatic in operation.

CHRISTCHURCH ELECTRICITY SUPPLY.

The annual report of the municipal electricity department of Christchurch, N.Z., states that the year ended March 31, 1925, proved to be the most satisfactory financially in the history of the undertaking. The revenue increased by £23,114, or 18.7 per cent, over that for the previous year, and the number of consumers increased by 11.9 per cent. Probably the most significant development has been in the installation of electric ranges and water heaters, the numbers connected to the mains at the end of the period being 475 and 655 respectively. The working expenses also have increased by £7,380; the bulk of this is accounted for by overhead distribution line maintenance. The council takes supply in bulk from the Lake Coleridge station of the public works department, and maintains a 750 kw. steam plant as a standby and to assist on peak loads. During the year the public works department's supply failed on 16 occasions, most of which were of only a few moments' duration. The steam plant was used to reduce peak load on 17 occasions, giving a maximum output of 360 kw.

A steady expansion is being effected in the reticulation system. Additions have been made to the 11,000 volt equipment in the main substation, and a 2,000 kw. synchronous condenser, for power factor correction, is on order. The 11,000 volt underground primary distribution has been extended, bringing the total length of cable up to 23 miles. A small addition was made to the 11,000 volt overhead system, while the 3,000 volt overhead lines have been somewhat reduced in length. Five new substations have been put into operation during the year. One of these is

designed for an ultimate capacity of 300 kw. and the others for 600 kw. New low tension overhead mains erected total 88½ miles of single run, and 64½ miles of mains have been replaced. The total route mileage of low tension lines is now 218. For street lighting 22-250 c.p. and 42-100 c.p. lamps have been erected and three miles of new mains have been installed.

For the furtherance of its business the council maintains a show room and wiring department. There is also a garage where electric vehicles, to an average number of 36 during the year, are charged. The combined results of the operations of these departments during the year have provided an amount more than sufficient to meet interest on capital. In connection with the wiring, not only does the department carry on trading activities, but it gives financial assistance to prospective consumers for the carrying out of installations. Under this scheme 224 loans were issued and 201 repaid during the year. At present there are 729 loans issued, the total amount being £9,564. On this work there is a slight debit balance which is borne by the general supply business. The department also issues licenses to wiremen, on examination. During the year 26 first grade and 40 second grade licenses were thus issued.

The contract for bulk supply from the public works department having expired, a new contract has been made which provides for supply over a period of 12 years. The council has been seriously considering the establishment of its own hydroelectric works at Otarama on the Waimakariri river, but the terms of the new contract are of such a nature that the local scheme will not be proceeded with for the present. To provide for expansion of the distribution system during the next five to seven years a loan of £375,000 has been arranged. Mr. E. Hitchcock is general manager of the electricity department, and Mr. J. C. Forsyth is city electrical engineer.

Statistics for year ended Mar. 31—

	1924	1925
Units purchased	21,688,000	25,656,410
Units generated	8,610	3,720
Units sold	18,979,956	22,511,181
Maximum demand—kw.	5,640	6,460
Load factor—per cent	44	45.5
Connected load—kw.	36,393	43,068
Number of consumers	20,090	22,490
	£	£
Capital outlay	480,437	559,144
Total revenue	123,432	146,546
Cost of current	26,109	29,599
Working expenses	26,181	33,561
Interest	19,619	21,681
Depreciation	28,733	27,852
Preliminary expenses written off	—	19,533
Profit	22,790	14,320
	d.	d.
Revenue per unit sold	1.56	1.56
Working costs per unit sold	.662	.673
Capital charges per unit sold	.612	.736

GOVERNMENT POWER STATIONS IN NEW SOUTH WALES.

The N.S.W. railway commissioners operate power stations at White Bay and Ultimo in the city area and at Zarra street, Newcastle. The White Bay station has a capacity of 51,000 kw., and in conjunction with the 36,500 kw. station at Ultimo, supplies energy for tramway and railway operations and to bulk consumers in Sydney and the surrounding districts. Considerable extensions are in hand at White Bay. The erection of an 18,750 kw., 25-cycle, 6,600-volt turbo-alternator, supplied by the English Electric Co. of Australia Ltd. is nearing completion, and a second similar unit is in course of construction by the same firm. Two 22,000-kw., 50-cycle, 11,000-volt turbo-alternators have recently been put into service, and a third similar unit is on order. A 7,500-kw., 25-50-cycle, 6,600-11,000-volt frequency changer is also being installed. Eight new boilers, with a maximum evaporation of 70,000 lb. per hour each, have recently been installed, and a new boiler house is in course of erection. During the next year six further boilers with capacity of 100,000 lb. per hour each will be available for service. A new turbine room and switch house have been built at the station. At Ultimo alterations in the circulating water arrangements have been made, in connection with which a new inlet tunnel has been completed, and screening chambers are in course of erection.

The total energy generated at the two stations during the year was 174,152,284 units, comprising 82,758,914 kw.h. at Ultimo and 91,393,370 kw. h. at White Bay. Of the current generated at Ultimo, 62,220,100 kw.h. was furnished by the 25-cycle plant, 14,476,231 kw.h. by the 50-cycle plant, and 62,583 kw.h. by the d.c. plant. Of the current generated at White Bay, 82,935,670 kw.h. was supplied by the 25-cycle plant and 8,457,700 kw.h. by the 50-cycle plant. The Sydney city council is the largest single consumer of bulk supplies, and took 26,500,938 kw. h. during the year. The output of the 50-cycle plant altogether was 22,126,948 kw.h., an increase of 13,762,009 kw. h. over the previous year.

Additions to the transmission and distribution system include a 1,000 kw. automatic converter station at Forest Lodge, the installation of a 450 kw. converter in the Rose Bay automatic substation, the installation of automatic switch-gear at Ryde substation, and the installation of an additional 500 kv.a. transformer at Clyde workshops. Three 1,000 kw. converters are in course of erection at the Prince Alfred substation, and two 1,000 kw. machines are on order for the Meek's-road substation. In the 11,000-volt system over 14 miles of overhead lines and

26 miles of underground cable have been placed in position.

The Zarra-street power house at Newcastle has an installed capacity of 24,000 kw., one 7,500 kw. turbo-alternator having been put into operation during the year. The energy output from the plant was 35,825,429 kw.h., of which 21,624,180 kw.h. was supplied to the Newcastle city council, 1,875,200 to the Walsh Island dock-yard, 1,215,890 to West Maitland, 924,600 to the Sulphide Corporation Ltd., 388,132 to the Newcastle Coal Mining Co. Ltd., 365,358 to Broken Hill Pty. Ltd., 258,840 to the Singleton municipal council, and 78,820 to the Tarro shire council. The balance of the energy was used for the requirements of the railway department. During the year supply was first given to the Sulphide Corporation at Cockle Creek, to which district 8½ miles of 33,000-volt mains were erected. A commencement has been made with a cross-country transmission line between Cockle Creek and West Maitland.

GREATER BRISBANE ELECTRIC SUPPLY TARIFF.

The Greater Brisbane council now has control of the electric supply undertakings formerly administered by the metropolitan electricity board, embracing the districts of Balmoral, Corparoo, Enoggera, Kedron, Sandgate, Toombul, and Wynnum. The following scale of charges for supply has been arranged:—Private lighting, 6d. per unit, discount 10 per cent.; domestic power, first 200 units per month 3d. per unit, next 200 units 2½d. per unit, a further 300 units 2½d. per unit, and for all in excess 2½d. per unit, discount 10 per cent.; industrial power on the maximum demand system, 9d. per unit for the first hour, plus 1d. per unit for all units consumed, discount 20 per cent.; picture shows, 5d. per unit; railway department for station lighting, 4d. per unit. Mr. J. H. Hindman is manager of the electricity department of the council.

A RECORD SURFACE CONDENSER

The Westinghouse Electric and Manufacturing Co., U.S.A., has recently completed the construction of what is claimed to be the world's largest single condenser unit. This piece of apparatus, which has been built for the Port Richmond power plant of the Philadelphia Electric Co., has a cooling surface of 70,000 sq. ft. made up of 12,734 one inch tubes each 21 ft. 3 in. in length. The condenser will be supplied with circulating water by two pumps of 78,000 gal. per min. capacity, each driven by a 500-h.p. motor. The total weight of the condenser and auxiliary equipment is 440 tons. This unit is the first of 12 that are to be installed ultimately in the Port Richmond station.

QUALITY OF ELECTRICAL MATERIAL.

It is stated that many complaints are being made by consumers in New Zealand of the poor quality of some of the electrical material being sold, the chief trouble being with lamps. The position is such that the government intends taking the matter up, and contemplates the establishment of a central testing laboratory, with a view to ascertaining the sources from which the poor quality apparatus comes and taking steps to prohibit its importation. A certain measure of inspection of a general nature is now being undertaken by the fire underwriters as well as by some of the local authorities, but it is considered that the time is ripe for the establishment of a central body to deal with the matter on a comprehensive scale.

If the complaints are well founded, action should certainly be taken without delay. The Dominion is in the midst of a period of unparalleled advancement, and anything which might have a tendency to check the present expansion should be ruthlessly rooted out. All classes of electrical interests should assist the government in any endeavors it may make in the direction of maintaining a high standard of quality in material marketed. By concerted effort in this direction the traders will not only render a service to the community, but will directly advance their own interests.

ELECTRICAL WORKERS' BOARD, QUEENSLAND.

Meetings of the board were held on August 25 and September 1 and 15. As a guide to the board in the consideration of applications of applicants for examination or for certificates without examination, who claim in support thereof experience in electrical work during war service, a synopsis of the class of work performed by various engineering units during the war has been obtained from the defence department.

In order to overcome the practice of one person holding more than one certificate, it has been decided to obtain from the crown law office a ruling as to whether the board has power to issue on one form all the different classes of certificate to which a person may become entitled. If the board has this power it will recall and cancel all the previous certificates issued in such cases, so that they may be included on one certificate.

A legal opinion is also being obtained concerning the powers of the board in making recommendations to the minister with regard to amendments of the electrical workers' act or regulations, and with regard to recommendations to the industrial arbitration court for insertion in the electrical trades award.

Permission has been granted to eight persons to sit for examination for certificates of competency, and 23 certificates have been granted without examination.

TWO-PART TARIFF AT MILDURA, VIC.

In the supply undertaking of the municipal council of Mildura, Vic., the charges for domestic energy supply have been, 1/- per unit for lighting and 2½d. per unit for power. With a view to encouraging the use of electricity, the council recently decided to introduce a one meter two-part tariff. After very careful consideration of various systems of charging, it was agreed that the service charge be based upon the average consumption of energy for lighting during the previous two years of each particular consumer. The charge is arrived at by multiplying this average number of units by 9½d., i.e., by the difference between the old lighting and power rates. The energy charge is the same as the old domestic power rate, viz., 2½d. per unit. For example: the average lighting consumption of a certain consumer for the past two years was 155 units; this, multiplied by 9½d., gives a service charge of £6/2/8½. Now the total energy used for lighting and power by this consumer was 188 units. Therefore, assuming his consumption will be the same during the next year his energy charge will be 188 x 2½d. = £1/19/2. The total amount he will pay for energy will then be £8/1/10½, which is what he would have paid under the old tariff.

The system is designed to ensure that the supply undertaking will receive the same revenue from the same number of units consumed under the new tariff as under the old. In computing the service charge the average of the consumption over the previous two years has only been taken in cases where the consumption was fairly even. Where there has been a considerable increase, the figure for the last 12 months only has been taken into account. The system is primarily for domestic use and its adoption by consumers entirely voluntary.

ELECTRIC SUPPLY TARIFF REDUCTION IN MELBOURNE

The Melbourne city council has adopted a recommendation of the electric supply committee for a reduction of the electric lighting tariff throughout the council's supply area by ½d. per unit during the summer months—October to March. The new rates are: First 1,000 units per month, 3d. per unit; next 1,000 units, 2½d., all further consumption 1½d. per unit. The reduction is made with a view to assisting shopkeepers and others who use large amounts of energy for lighting.

LICENSING OF ELECTRICIANS.

A deputation from the Australian Electrical Union, N.S.W. branch, recently waited on the assistant minister of health and local government of New South Wales, urging the licensing of working electricians. The secretary of the union said that licensing was the only system by which incompetent workers could be excluded. It would prevent unscrupulous employers from engaging incompetent men who worked for less than award rates, thus protecting the public.

The minister, in reply, said that the present act gave protection to the employer but not to the man who actually did the work. It was not in operation, however, because certain regulations had not been considered. Either the act would have to be replaced by one making the desired provisions, or else it would be amended to provide for the licensing of workmen. He promised to make a recommendation to the Cabinet.

THE JACKADGERY HYDROELECTRIC SCHEME

The present government of New South Wales has stated that it is not prepared to associate itself financially with the Jackadgery scheme for the development of hydroelectric power from the Clarence river, although it approves of the formation of a county council to control the proposed enterprise. The opinion of the government is that the scheme will be very costly and is not likely to make an appreciable difference in promoting closer settlement.

Mr. H. G. Carter, chief engineer of the public works department, states that the scheme has serious weaknesses, both financially and technically. In the first place it is noted that the energy is to be created by the construction of a dam below the junction of the Mann and Nymboida rivers, and that the dam itself would provide the necessary head, there being little natural fall. In general such a method of development is costly, and in this particular case it is estimated that the scheme would cost at least £150 per effective kw. Such a high figure might possibly be accepted were the power available continuously, but the estimates are based on a 30 per cent load factor. For the ultimate development of 20,000 h.p. the cost may come down to £120 per kw. The principal feature against the scheme is that no revenue can be earned until the whole of the estimated cost, £1,500,000, has been expended. It is in view of these facts that the government has decided that it cannot give financial assistance.

Radio News

A wireless station has been opened at Wave Hill, the most southerly cattle station in the Victoria River district of the Northern Territory, about 500 miles from Darwin.

The Australian Inland Mission is erecting a 50 watt transmitting station at Alice Springs. The call signal will be 8AB, and the wave length will probably be 200 metres. The generator will be operated by a belt drive from the rear wheels of an automobile. The set has been presented by Amalgamated Wireless (Aust.) Ltd., and it will be used for providing a broadcast service for people outback.

HARBOR WIRELESS.

The harbor board at Auckland, N.Z., is considering the installation of radio apparatus on the tug Te Awhina, in order to increase its efficiency when called upon to render assistance to vessels in distress. Lack of wireless facilities has in the past materially militated against the success of the tug's operations in this direction. It is estimated that a portable set, with range of 100 to 150 miles, would cost about £250. The set could be transferred to a dredge or any other plant called upon to leave the harbor. Operators would be drawn from the ranks of the harbormaster's signallers, who would be required to take a course in wireless operating.

2-KW. TRANSMITTERS FOR U.S. COAST-GUARD SERVICE.

The United States government has recently installed three 2-kw. radio transmitting equipments on its ice patrol coastguard vessels. These transmitters are an excellent example of the improvements that have been made in valve transmitter design during the past few years. Each will deliver an output of 2-kw. to the antenna over frequency ranges from 107 to 187 kilocycles (2,800 to 1,600 metres), and from 312 to 500 kilocycles (960 to 600 metres). The frequency is continuously variable within each range, and it is possible to change from one transmitting frequency in each band to any other within the band in a few seconds. Moreover, settings can be made with an accuracy of better than 350 cycles or within 0.07 of one per cent, once the circuits have been properly calibrated. Three forms of signalling are provided:

straight continuous wave, tone modulated telegraphy, and telephony. A separate telephone attachment is used for telephony and tone telegraphy.

A new type of vacuum tube, the UV-851, was developed in order to meet the requirements of the transmitter. This valve is rated at 1 kw. output on a plate supply of 2,000 volts d.c. A thoriated filament is used, which consumes 15.5 amps at 11 volts. The plate supply is provided by a simple two-unit motor generator set. Prior to the development of this valve the only 1 kw. valve available was one requiring a plate potential of 10,000 to 15,000 volts d.c. An analysis indicated that the rectifier necessary to supply this high d.c. voltage would be too bulky for the particular shipboard service, and in addition the insulation problems attendant upon the high voltage would make the transmitter too large.

The transmitter proper uses seven valves operating in a master-oscillator power-amplifier circuit. The master oscillator is a 50-watt UV-211 valve. Four similar valves operate in parallel as intermediate amplifiers and prevent reaction on the frequency determining circuits of the master oscillator. The two UV-851 main power amplifier valves are connected in parallel and deliver power to the antenna through the antenna transformer. All seven valves are supported in a cradle suspended by springs and cushioned with sponge rubber. The telephone attachment uses one of the UV-851 valves as a modulator, and a UV-211 valve as a speech amplifier. On tone telegraphy a specially designed alternator is connected in circuit in place of the microphone.—“G. E. Review.”

THE DAVENTRY STATION OF THE BRITISH BROADCASTING CO.

The British Broadcasting Co. has recently put into commission its new high-power broadcasting station situated at Daventry, Northamptonshire, England. The station operates with a power output of 25 kw. on a wave length of 1,600 metres. The call signal is 5XX, which was the call of the Chelmsford experimental plant the functions of which the new station has taken over. The programmes to be transmitted are relayed from the company's London studio by means of a post office land line.

The station is situated on a hill at about 650 ft. above sea level. There are two masts, each 500 ft. high, placed 800 ft. apart. The actual aerial is 600 ft. long and consists of 10 wires supported on hoops 5 ft. 6 in. in diameter. The down lead runs from the centre of the aerial, and consists of a six wire cage. This enters the roof of the station building which is situated midway between the masts. Winches for lowering the aerial are provided on each mast. On

the platform of each mast is a bowl shaped warning light for aircraft.

The earth system consists of three copper sheets buried beneath the station itself, to which all machinery and frame work is earthed, and of 36 zinc plates disposed round the building in a 100-ft. circle. Insulated wires from these earthed plates are each led on short masts over the roof of the building to the centre near the aerial down lead, both the aerial and the connection of the 36 earths entering the roof near one another and proceeding directly to the tuning inductance beneath. Such an earthing system forms an electrostatic screen over the roof, and probably reduces aerial losses to some extent.

The power to operate the station is derived by duplicate cables from the Northampton Electric Light and Power Co. at 11,000 volts, the supply being three-phase a.c., which is transformed down to 375 volts in a small substation. It was considered unsound to rectify the three-phase power directly for supplying the valve transmitter, as a slight unbalance on any incoming phase might cause difficulty in maintaining the requisite degree of “smoothing,” so rotary machines have been provided to furnish a single-phase supply. Besides pumps, etc., the power plant consists of three (one spare) 70-kw, 1,000-volt, 300-cycle motor-alternators for supplying power to the modulator and magnifier valves; two 25-kw., 1,000-volt, 300-cycle machines (one spare) for supplying power to the drive oscillator and for heating the filaments of all the rectifying valves; and three 10-kw motor-generators (one spare) delivering d.c. at from 20 to 30 volts for heating the filaments of the drive, sub-modulator, modulator, and magnifier valves. All these machines are fitted with individual self-excitors.

The independent drive unit comprises two air-cooled rectifying valves and one water-cooled oscillator, the former being arranged for full-wave rectification to supply d.c. at 10,000 volts through the usual smoothing circuit to the oscillator anode. The plate input to the drive oscillator is about 8 kw.

The magnifier is formed of four water-cooled rectifier and three water-cooled oscillatory valves; the latter are capable of dealing with an input of 30 kw. at 10,000 volts, and are normally operated at this voltage with a plate current of 2.5 amps. The filament input is the same for all the water-cooled valves used, viz., 1 kw. each at 20 volts. The modulator portion consists of four water-cooled rectifiers and six water-cooled modulators. The latter are similar in size and appearance to the oscillators, but have a much more open grid mesh with a low amplification factor. The modulator is worked with plate voltage and current equal to that of the magnifier,

the current being adjusted by the setting of the grid negative voltage; for normal working this setting is between 1,200 and 1,300 volts, negative. The grid negative voltage is obtained from a dry-cell battery.

The smoothing circuits for a set of this size present something of a problem, as the permissible ripple is very small for high-quality broadcast telephony, and the smoothing units are necessarily somewhat bulky and costly. The condensers consist of zinc plates with glass dielectric, oil-immersed in porcelain containers; the total capacity used on each half of the circuit is approximately 3.5 microfarads, and the inductance about 16 henrys. The smoothing inductances are closed iron-core chokes in oil tanks, each choke containing about 5 cwt. of iron, and there are eight of them in all.

The transmitting apparatus was designed and built by the Marconi Co. on the unit system, i.e., the apparatus for each operation is self-contained in polished aluminium framework. The control of the whole plant is effected from a control table in the transmitting room. Marconi-Osram valves are used throughout. Provision has been made to increase the output of the station to 50 kw. should the necessity arise.—“Electrical Review.”

Trade Notes

Change of Address.—As from November 1, the Victorian address of the Australian Westinghouse Electric Co. Ltd. will be Temple Court, Collins street, Melbourne.

Electrolux Ltd. has opened a new showroom at 334 Collins st., Melbourne, with excellent facilities for display and sales of the Electrolux suction household cleaner.

New Tasmanian Agency.—The British General Electric Co. Ltd. has appointed A. G. Webster and Sons Ltd., of Hobart, as its sole agent for Tasmania. The firm will carry representative stocks of all G.E.C. lines and its electrical department will be controlled by Mr. J.M. Bishop under transfer from the British General Electric Co. Ltd., head office, Sydney.

Corrosion Proof Armored Cable.—Messrs. British Insulated and Helsby Cables Ltd. have recently landed a consignment of corrosion proof armored cable to the order of the Melbourne tramways board, for use in connection with the conversion of the St. Kilda road tramway system to electric traction. The cable is of 0.6 sq. in cross section, single core, and the total length is about five miles. The special feature of this cable is a provision for keeping the sheath and armoring concentric and properly separated by a water proof compound filling under all conditions

of load. The means by which the desired end is attained were described in the February, 1925, issue of this journal. In the first designs a distance piece in the form of a wire spiral was used between the sheath and the armoring, but in the later cables, such as the one mentioned above, a spiral of hard rubber is used. With the filling of compound around this spacer there is no chance of moisture getting at the sheath and setting up corrosion.

Memrex Switches.—The Midland Electric Manufacturing Co. Ltd. has recently introduced a new series of ironclad quick make and break switches under the trade name of Memrex. The switches are made in double or triple pole, 15, 30, and 60 amp. sizes, with or without fuses. The design is compact and the workmanship of high grade. The contacts and terminals are mounted on porcelain blocks with removable covers, and are completely shrouded when the covers are in position. Each switch is designed to break 50 percent excess current at 50 percent excess voltage. With the combined switch and fuses a special new design of Kantark fuse is used. Extensions to the contacts and alterations to the arc chamber have been made with a view to minimising risk of maintenance of the arc. Switches of this series have been found to give every satisfaction under severe service conditions.

Aluminium Overhead Conductors.—The British Aluminium Co. Ltd., represented in Australia by Messrs. W. G. Watson and Co. has issued a book of 150 pages dealing with conductors. Steel cored aluminium conductors are now being very extensively used in overhead transmission work, and sufficient experience of their behaviour under conditions of practice is available to show their reliability and economy. The British Aluminium Co. is one of the largest manufacturers of such conductors, and it has brought out this handy little book as a supplement to its service and an assistance to designing engineers. The volume deals with the electrical and mechanical characteristics of aluminium and aluminium steel reinforced conductors, and gives valuable data regarding the design and construction of transmission lines using such conductors. Examples to assist in the determination of the values of the various factors taken into account are given, and the text is illustrated by numerous charts and descriptive plates and diagrams. As an appendix several useful tables of constants are included. The book is a useful contribution to the literature dealing with transmission line practice.

Weymouth's Ltd.—The directors of Weymouth's Ltd. (a subsidiary of the English Electric Co. of Australia) state that in some instances the new tariff proposals do not go far enough in providing protection to Australian

engineering industries. They are particularly surprised that the government did not afford better support to the local manufacture of electrical transformers, in view of the very complete evidence submitted to the tariff board on the difficulties connected with such manufacture and on the foreign competition to be taken into account.

The result of the company's trading for the year ended June 30 last shows a considerable drop in profits, compared with results for previous periods. This is due, the directors explain, to the fact that, to meet foreign competition, they had to accept orders at prices which left a very small margin over cost. The profit and loss account shows a balance of £2,711, from which it is proposed to distribute £2,625 in dividend of 5 percent. Balance-sheet items include: Subscribed capital, £52,500; reserve fund, £7,500; bank, £4,796; sundry creditors, including reserves for taxation, etc., £7,583. Assets: Land and buildings, £23,400; plant and machinery, £22,590; stock, £10,566; work in progress (less progress payments), £5,216; sundry debtors, £12,999.

The company has just received a very welcome order from the Victorian electricity commission for 40 transformers in capacities ranging from 200 to 500 kv.a. The amount of the contract is about £30,000, and preference has been given to the local manufacturer, although lower prices were received from abroad. Further, it has been decided that Messrs. Weymouth's shall, at the commission's option, supply the commission's transformer requirements for the next two years. It is estimated that, including the present order, about £80,000 worth of transformers will be required in the period.

A Valve Testing Instrument.—Amongst the many thousands of radio valves now being produced by various manufacturers, a great many, in spite of careful checking and testing at the works, are not up to standard when they reach the dealer. The sale of such valves must inevitably react unfavorably on both dealer and manufacturer, and it is essential, therefore, that all precautions be taken to ensure that the purchaser gets valves that are up to specification. Some months ago a brief description was given in these columns of a radio test set manufactured by the Jewell Electrical Instrument Co., U.S.A., by means of which the performance of valves could be checked. The same company is now producing a somewhat simpler instrument, known as a Tube Checker, by means of which the valve performance may be checked by the dealer, although the testing is not as complete as that carried out by the radio test set. The instrument comprises a valve socket, rheostat, filament voltmeter, milliammeter, and the necessary terminals, all mounted on a neat aluminium

case. In operation the valve under test is plugged into the socket, and the proper A and B batteries connected to the respective terminals on the instrument. The filament voltage is then adjusted to the correct value for the valve by means of the rheostat and voltmeter. The internal connections are so arranged that the valve grid is connected to the negative end of the filament, and under this condition the plate current is recorded on the milliammeter. By means of a push button on the side of the case, the grid may be connected to the positive end of the filament, thus giving an increased reading of plate current flow. These readings are checked against the specified performance values for the type of valve, and thus the relative efficiency of the valve under test is ascertained. The price of the Tube Checker is £10/19/-. Further information is obtainable from Messrs. L. P. R. Bean and Co. Ltd., Sydney, the Australian representatives of the manufacturers.

The Diverter Relay.—Balanced fault protection is now almost universally recognised to be essential on modern power systems, both for feeders and plant. Many of the systems in use are capable of very sensitive adjustment, but there is the disadvantage that, when the setting is fine, there is a liability to operation under conditions when tripping is not warranted. Thus, the large currents which flow through healthy feeder sections and generator and trans-

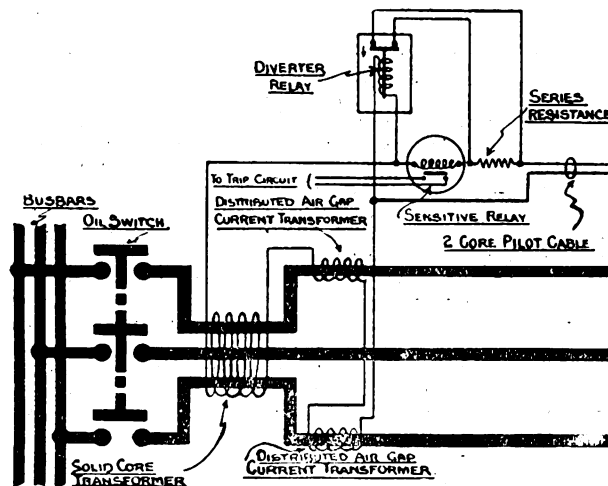


Diagram showing Application of Diverter Relay.

former windings when a fault occurs on another part of a large power system give rise in themselves to considerable unbalancing effects, and with a light relay setting will trip the breakers. Investigations have shown that the primary and secondary errors in balancing are cumulative, and so with ordinary current transformers and relays it is difficult to ensure a satisfactory margin between the fault current setting and the amount of through current at which the

relay would operate. In the protection of feeders of any length it is usually necessary to employ transformers of special design in conjunction with compensated pilot cables, in order to obtain a sufficient margin to give stable operation.

With the steady growth of transmission and distribution networks, and the need for closer interconnection, longer lines and more sensitive fault current settings, particularly to earth, are required, and other devices must be introduced to increase the margin between the fault current settings and the minimum straight through current at which the relay will operate. Economy in the cable layout is also of importance, and the omission of one wire or of the compensating sheaths of the pilot cable will effect considerable savings. The Diverter Relay is a piece of apparatus that effects improvements both in the sensitivity of the protection and the cost of the pilot cable. It is a relay of special construction which, as applied to a balanced protective system, is connected in the secondary circuit. It is inoperative within the

limits of ordinary commercial balance, but introduces a diverting or desensitising resistance in circuit with the sensitive relay necessary to secure low fault settings, when the straight through current reaches an abnormal value. The diagram illustrates the application of the relay to a combination of balanced earth leakage and Merz Price feeder protection. The Merz Price system with only a two core pilot does not give complete fault protection, but the addition of the diverter relay and an earth leakage feature to the circuit enables the fullest protection to be obtained, and makes it possible to eliminate the use of compensating sheaths for even the longest lines. With the arrangement shown one closed core current transformer may be used at each end of a feeder for the earth leakage feature, and two air gap current transformers for the e.m.f. balance between the two ends. The Diverter Relay is manufactured by Messrs. A. Revrolle and Co. Ltd., England. Further particulars of the instrument and its applications can be obtained from the English Electric Co. of Australia Ltd.

Lighting and Power

Ambleside, S.A.—The electric supply plant of the Ambleside Milling and Lighting Co. was opened on September 18. The company has been granted a 20 year franchise by the Onkaparinga district council for supplying electrical energy within the council's boundaries. The district has a population of about 2,500 and includes the towns of Balhannah, Oakbank, Woodside, Tweedvale and Charleton. The power house is at Woodside and is a brick and stone structure 100 ft. long by 35 ft. wide. The plant consists of two 240 h.p. crude oil engines each direct coupled to a 180 kv.a. alternator and one 60 h.p. crude oil engine direct coupled to a 45 kv.a. alternator. The engines were built by Messrs. Vickers, Petters Ltd., England, and the alternators by the British Electric Plant Co., Scotland. The equipment was supplied through the agents, the Southern Electric Power Co. Ltd., Adelaide. All station auxiliaries are electrically driven and there is a 5 h.p. oil engine held as a standby.

The generating voltage is 400, 50 cycle a.c., and the energy is stepped up in E.M.F. transformers to 11,000 volts for transmission. Distribution is carried out at 400/230 volts. Oil supplies for the engines are stored in a 16,000 gal. tank filled by gravitation from bulk rail cars at the Woodside station. Cooling water is pumped from the Onkaparinga river to a 43,000 gal. tank. The installation was carried out under the superintendence of Mr. A. H. Dines of Vickers, Petters Ltd. Mr. F. M. Houlton, R.E., is the consulting engineer.

Auckland, N.Z.—The Waitemata power board is reducing the domestic power tariff to 3d. per unit for the first 30 units per month and 1½d. per unit for all in excess, with discount of 12½ per cent for prompt payment. The previous rate was 3d. for the first 20 units, 2d. for the next 10 units and 1½d. for all in excess.

The Auckland power board is about to seek authority from the ratepayers to raise a loan of £650,000 for electric supply purposes. The proposed works include preparation for receiving supply from Arapuni.

Avoca, Vic.—In connection with the electric supply scheme tenders have been accepted for the erection of the power house building and the supply of poles.

Baulkham Hills, N.S.W.—The Sydney city council has agreed to let the shire council have bulk electricity supplies on the following terms:—Annual charge, £875; maximum demand charge, £5/11/6 per kv.a.; energy charge, .845d. per kw. hr.

Blacktown, N.S.W.—The shire council is borrowing £30,000 for electric supply purposes. It is proposed to supply Toongabbie, Northmead, Seven Hills and Doonside.

Casino, N.S.W.—The municipal council has accepted the following tenders in connection with the electric supply undertaking:—Erection of power house, P. F. Small £1,371/17/10; erection of poles and wires, Foster and Fish, £631/5/-.

Cunnamulla, Q'ld.—The Paroo shire council is inviting tenders for generating plant and reticulation material for its electric supply installation. Mr. T. W. Bridger, of Brisbane, is consulting engineer.

Ermington and Rydalmere, N.S.W.—The Sydney city council has agreed to let the local council have bulk electricity supplies on the following terms:—Annual charge, £280; maximum demand charge, £5/15/- per kv.a.; energy charge, .85d. per kw. hr.

Euroa, Vic.—The shire council has installed a 93 h.p. engine to take the place of the one that was damaged some months ago.

Gerrington, N.S.W.—The council has had an electric supply scheme under consideration, and proposed to borrow £9,500 to finance the installation. A section of the community, however, is opposed to the proposal to levy a rate in connection with the scheme, and the council's resolution in favor of the undertaking has therefore been rescinded.

Gore, N.Z.—The borough council has arrived at an agreement with the Southland power board for the supply of electricity. The board has undertaken to supply energy up to a maximum of 600 kv.a. The council

has been purchasing bulk supplies of energy from the Southland Frozen Meat Co. at Mataura.

Grafton, N.S.W.—The total connections to the Nymboida hydroelectric scheme have now reached 1,021. On September 26, twenty further applicants were awaiting service.

Kangaroo Flat, Vic.—In connection with the proposal to give electric supply in the district the electricity commission has intimated that the Electric Supply Co. of Victoria Ltd., is prepared to give supply from Bendigo provided the Marong shire council will supply the necessary high tension main, transformers and reticulation.

Kerang, Vic.—The shire council's electric supply undertaking shows a profit of £801 for the eleven months ended Aug. 31 last.

Manunui, N.Z.—The town board is raising a loan of £5,000 for electric supply purposes.

Moree, N.S.W.—An extension of franchise has been granted by the council to the Moree Electric Light Co. Ltd., for a further period of ten years, subject to the condition that the current charges be as follow:—First two years, 10d. per unit; next two years, 9d. per unit; remaining six years, 8d. per unit.

Murchison, Vic.—The Waranga shire council is having a report prepared on an electric supply scheme.

Penrith, N.S.W.—The local government department has refused permission for the municipal council to borrow £7,000 for electrical extensions without the sanction of the ratepayers. In consequence the council is not proceeding with the proposal.

Pinnaroo, S.A.—Work is about to be put in hand on an electric supply scheme under which the district council will take bulk supply from the flour mill of the S.A. Farmers' Co-operative Union Ltd. The present motive power at the mill is a 120 h.p. Vickers-Petters heavy oil engine, and as this is only half loaded it is intended to belt couple a 74 kv.a. alternator to the engine pulley, and extend the engine shaft and drive the mill from a second pulley fitted with a clutch. For light load running, when the mill is shut down, a new model 25 h.p. Vickers-Petters engine and 20 kv.a. alternator with belt drive is to be installed. Both alternators are being manufactured by the British Electric Plant Co., Scotland, and are intended to operate in parallel.

The switchboard will be under the joint ownership of the mill proprietors and the district council, the dividing point being a metering panel with two meters, one owned by each authority. The distribution system is to be 400/230 volts, 50 cycle, three phase a.c., and the prices to consumers will be 1/4 for lighting, 8d. for domestic power, and 5d. for motors, with meter rent at 8d. Street lighting will be effected by 33 100-watt lamps.

It is expected that, at the outset, there will be between 100 and 120 consumers, and provision is being made for increases in the demand. The mains will extend through about 4½ miles of streets. The details of the scheme have been worked out by the Southern Electric Power Co., which is supplying the whole of the plant and erecting the distribution system.

Pukekohe, N.Z.—A deputation from the Auckland Wholesale Electrical Traders' Association recently waited on the Franklin power board on the question of a mutual co-operative understanding in regard to trading operations in the board's district. The board has not yet decided the extent of its trading policy.

Rockhampton, Q'ld.—Mr. H. Kingdom Rowe, electrical engineer and manager of the council's electric supply undertaking, has recommended that £40,000 be borrowed for extensions to the service.

Singleton, N.S.W.—The municipal council has agreed to extend electric supply to Kelso and Glenriding provided that a minimum revenue is guaranteed. The prices charged are to be 1/2 per unit for lighting and 8d. per unit for power, with discount of 2d. per unit. Figures for the present undertaking covering the half year ended June 30 last show that the receipts amounted to £2,661; while the expenditure, including interest, totalled £2,586.

Te Awamutu, N.Z.—The Te Awamutu power board is considering the installation of static condensers for power factor improvement. At present the number of consumers connected to the board's mains are as follow:—Lighting, 1,013; milking plants, 340; other power plants, 346; water pumping, 42; ranges, 34.

Te Kuiti, N.Z.—The Waitomo power board has been authorised to purchase the electric supply undertaking of the Te Kuiti borough council.

Wagga, N.S.W.—A draft agreement has been drawn up covering the bulk supply of electricity to the town from the Burrinjuck hydroelectric development of the public works department. The price will be 1d. per unit. It is estimated that the saving to the town will be £5,000 annually as against the cost of using the present steam plant.

Wedderburn, Vic.—The Korong shire council is raising a loan of £7,000 for an electric supply scheme for Wedderburn and Korong Vale. The power house will be situated at Wedderburn.

Westbury, Tas.—The council is giving consideration to an electric supply scheme for Westbury, Hagley and Exton. Mr. C. B. Davies, consulting engineer, has submitted a report on a scheme for taking bulk supply from the hydroelectric department.

Whangarei, N.Z.—The borough council now has 900 consumers on its electric supply system, out of a population of 4,100. In the first year of operations 150,880 units were sold; last year, which was the fifth, 442,733 units were sold.

Current Prices for Electrical Supplies

The quotations in this list represent the average retail selling prices ruling in Melbourne during the month of publication. These prices are subject to bona fide traders' discounts. Special rates are obtainable in most cases for large quantities. In general Sydney prices are slightly lower.

Adaptors—

Hardwood	doz.	12/6
Parallel	each	6/6

Blocks—

3 in. round	gross	22/6
3½ in. round	gross	25/-
6 in. x 3 in. rectangular	doz.	6/3
9 in. x 3 in. rectangular	doz.	7/6
6 in. x 6 in. square	doz.	12/6

Bushes—

1 in. ideal metal	gross	7/6
2 in. ideal metal	gross	7/6
3 in. ideal metal	gross	8/9
4 in. plain wooden	doz.	1/6
5 in. plain wooden	doz.	1/8
6 in. plain wooden	doz.	2/-

Bells and Bell Material—

Bell transformers	each	10/6
1½ volt dry cells	each	3/-

Bells and Bell Material—

Bell wire—1/029 d.c.c.	1,000 yd.	32/6
1/036 d.c.c.	1,000 yd.	42/6
1/029 d.c.c. and i.r.	1,000 yd.	50/
1/036 d.c.c. and i.r.	1,000 yd.	60/
No. 2 porous pots	each	2/
No. 2 jars	doz.	8/9
No. 2 zincs	each	1/3
Salammoniac	lb.	1/3
2½ in. wood box bells	each	4/6
2½ in. iron box bells	each	4/6
3 in. wood (church gong)	each	18/4
Bell presses	from each	3/9

Pocket Lamp Batteries—

Batteries, pocket lamp	each	1/10
2-cell batteries	each	2/5
3-cell batteries	each	2/8

Ceiling Roses—

	English	Japan
2-plate	doz. 12/1	6/3
3-plate	doz. 15/	8/3

Connectors—

1-way, porcelain	doz.	2/6
2-way, porcelain	doz.	4/
3-way, porcelain	doz.	5/

Counterweights—

Porcelain	each	2/6
Brass	each	5/6
Shot for same	lb.	6½d.

Casing and Cover—

Best white pine	100 ft.	10/
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Conduit—

	Plain	Screwed
½ in.	100 ft. 9/2	20/
¾ in.	100 ft. 10/	20/
1 in.	100 ft. 15/	57/6
1½ in.	100 ft. 27/6	40/
2 in.	100 ft. 45/	60/
2½ in.	100 ft. 68/	85/
3 in.	100 ft. —	135/
¾ in. oval	100 ft. 12/6	—

Conduit Fittings—

	½ in.	¾ in.	1 in.
Grip—Tees	doz. 3/6	3/6	4/3
„ Elbows	doz. 2/9	2/9	3/6
„ Couplings	doz. 2/3	2/3	2/9
Crampets	gross 5/5	5/5	6/3
Saddles	gross 5/	5/	5/5
	½ in. & ¾ in.	1 in.	
Screwed tees	doz. 5/5	7/6	
„ elbows	doz. 3/9	5/5	
„ couplings	doz. 2/9	4/	
„ bell mouths	doz. 5/	5/	
„ „ 1 in.	doz. 14/10		
„ „ 1½ in.	doz. 19/6		
„ „ 1½ in.	doz. 27/		

Junction Boxes—

	½ in. & ¾ in.	1 in.
2-way	doz. 10/10	10/10
3-way	doz. 11/3	11/3
4-way	doz. 11/3	11/3

Fuses (Cut-outs)—

	British	Japan
5 amp, anchor type	doz. 10/	5/
5 amp, round chamber	doz. 17/6	8/9
8 amp, round chamber	doz. 20/	12/6
10 amp, oblong	doz. 35/	25/
20 amp, oblong	each —	3/

Holders—

	English	Japan
C/G., S/C. holders	doz. 12/6	8/9
½ in. and ¾ in. holders	doz. 12/6	8/9
Batten holders	doz. 13/9	10/

Lamps—**Metal Filament, Vacuum Type**

25 to 250 volts, 20 to 60 watt	each	2/
20 to 250 volts, 100 watt	each	5/

Gas-filled Type

20 to 250 volts, 25 to 40 watt	each	2/9
All voltages	60 watt	each 3/3
	75 watt	each 3/9
	100 watt	each 5/3
	150 watt	each 7/
	200 watt	each 9/
	300 watt	each 13/
	500 watt	each 17/6
	750 watt	each 22/6
	1000 watt	each 27/6
	1500 watt	each 40/

Carbon Filament

All voltages, 5 to 32 candle power	doz.	24/
All voltages, 50 candle power	doz.	42/

Plugs—

5 amp two pin plugs	doz.	30/
5 amp two pin tops	doz.	15/

Shades, Opal—

8 in.	doz.	11/3
9 in.	doz.	17/6
10 in.	doz.	21/3

Switches—

	English	
5 amp s.p. pol. brass	doz.	17/6
5 „ s.p. ox. copper	doz.	19/3
5 „ 2-way pol. brass	doz.	30/
5 „ 2-way ox. copper	doz.	33/
10 „ s.p. pol. brass	doz.	37/6
5 „ d.p. pol. brass	doz.	40/
10 „ d.p. pol. brass	doz.	85/
5 „ s.p. ceiling switches	each	5/6
5 „ 2-way ceiling switches	each	7/6
1 „ ceiling switch and rosette	each	5/6
3 amp American tumbler	doz.	24/
3 „ s.p. indicating rotary	doz.	24/
3 „ s.p. non-indicating rotary	doz.	22/6
3 „ 2-way rotary	doz.	56/3
5 „ d.p. indicating rotary	doz.	62/6
10 „ d.p. indicating rotary	doz.	78/
20 „ d.p. indicating rotary	doz.	150/

Switchboards—

	English	Japan
Single circuit marble 5 amp	each 9/9	8/
Single circuit marble 10 amp.	each 17/6	16/3
Two circuit marble 5 amp	each 19/2	15/10
Two circuit marble 10 amp	each 25/	22/

Switchboard Frames—

6 in. x 6 in. local make	doz.	9/6
6 in. x 8 in. local make	each	1/
8 in. x 8 in. local make	each	1/3
8 in. x 10 in. local make	each	1/6
10 in. x 10 in. local make	each	1/8

Tape—

Black adhesive	lb.	2/9
Pure rubber	lb.	10/

Wire and Cables—

Per 1,000 yd.

1/.044, 600 meg.	£7	3	4
1/.064, 600 meg.	10	5	0
3/.036, 600 meg.	11	15	0
7/.036, 600 meg.	20	10	0
7/.044, 600 meg.	26	0	0
7/.064, 600 meg.	43	10	0

Flexibles—

Per 100 yd.

23/.0076 cotton	£2	5	0
40/.0076 cotton	2	16	8
70/.0076 cotton	3	11	8
110/.0076 cotton	4	13	4

Electrical Contracts

STATES

Dept. of Agriculture, Victoria.—Two water tube boilers; two complete sets of Diamond mechanical soot blowers—Babcock and Wilcox Ltd.

N.S.W. Public Works.—Electrically driven pumping machinery, Blackheath water supply—Worthington-Simpson Ltd.; tour 200-kv.a. 3 phase, transformers, Kiama-Nowra transmission line—English Electric Co. Ltd.

N.S.W. Railways and Tramways Dept.—Two 50-kv.a. transformers—Electrical Plant Manufacturers Pty. Ltd.; three transformers—English Electric Co. Ltd.; two ash conveyors for White Bay power house—West's Gas Improvement Co.; 2 steam driven boiler feed pumps—Ferrer and Dickinson Ltd.; 123,600 yd. 11,000 volt cable—Enfield Cable Works (Australia) Ltd.

South Aust. Supply and Tender Board.—220 miles H.D. copper line wire; 13,200 tapes; 13,200 binders—Elder, Smith and Co. Ltd.; 13,200 glass insulators—Unbehaun and Johnstone Ltd.; telephone train control material—Elder, Smith and Co. Ltd., and Unbehaun and Johnstone.

State Electricity Commission of Vic.—Elect. motor driven centrifugal pumps—Thompson and Co. (C'maine) Pty. Ltd.

West. Aust. Supply and Tender Board.—Electric lamps—Atkins (W.A.) Ltd., Gibbs, Bright and Co.

GENERAL

Sydney City Council.—Street lighting lamp brackets—Palmain Motor and Engineering Works; 5,000/33,000 volt transformer—Austral Electric Ltd.; 100 automatic cut-outs and substitutional resistances—Electrical Manufacturers Limited; L.T. pin type insulators—British General Electric Co. Ltd.; 33,000 volt covered cables—Noyes Bros. (Syd.) Ltd.; maximum demand indicators—Edison Swan Electric Co. Ltd.; overhead service fittings—C. Crompton.

NEW ZEALAND

Christchurch City Council.—3,000 bobbin insulators, 4,000 pin insulators, 2,000 single shackle insulators, and 3,000 double shackle insulators—Turnbull and Jones.

Franklin Power Board.—Electric motors—Bycroft Bros. (Parkinson).

Invercargill Borough Council.—1 static condenser—Parkinson (N.Z.) Ltd.; 4 transformers—Cory, Wright and Salmon; underground cable—Turnbull and Jones Ltd.

Marlborough Electric Power Board.—Headworks contract—W. Williamson.

Public Works Department.—Waikato, section 126: 11,000-volt switchgear—Metropolitan-Vickers; section 127: 50,000-volt transformers—Cory, Wright and Salmon (English Electric).

TENDERS OPEN COMMONWEALTH

P.M.G.'s Dept., General.—Oct. 20—Jumper wire, bells, buzzers, switchboard cable. Oct. 27—Timing clocks and calculagraphs, cordless switchboards, telephone transmitters and associated parts. Nov. 10—Sulphate of copper; telephone receivers and associated parts; dry cells. Nov. 17—Junction material, magneto. Dec. 1—Motor generators. Dec. 15—Junction apparatus for manual exchanges. Dec. 22—Accumulators and C.E.M.F. cell batteries. Dec. 29—Magnet and resistance wire.

P.M.G.'s Dept., N.S.W.—Nov. 6—Automatic common battery, telephone equipment, Canberra exchange.

STATES

N.S.W. Public Works Dept.—Oct. 19—Electrically operated belt conveying plant. Oct. 21—Transformers, insulators for switchgear. Oct. 26—Installation of electric lighting, Bathurst district hospital, oil engines, generator

and switchboard. Nov. 30 (extended)—Metering equipment for substations; Kiama-Nowra transmission line and Barren Jack hydroelectric development.

N.S.W. Railways and Tramways.—Oct. 21—Two-ton industrial electric elevator; three-ton and five-ton electric overhead travelling cranes. Nov. 11—Five-ton three-motor, electric overhead travelling crane. Dec. 16—Ten 1,800-kv.a. single phase transformers. Dec. 23—Air cooler. Jan. 13, 1926—Four 3,000-kw. rotary converter units; 1,000 kv.a. transformer. Jan. 20—100 40-h.p. fraction motors, two 500-kw. rotary converter units. Jan. 27—Two 500-kw. converter units.

State Electricity Commission of Vic.—Nov. 9—6,600-volt and L.T. lead covered and armored cable; 22,000-volt, 3-core lead covered and pilot cable; 6,600-volt trailing cable. Dec. 14—22,000-volt insulators. Dec. 29—1,000 kv.a. transformers. April 12—Spec. 26/1 Turbo-generators, transformers, switchgear, cranes and accessory plant for Sugarloaf-Rubicon hydro-electric scheme.

Victorian Railways.—Oct. 21—Electric cables, electric transporters and equipment. Oct. 26—Portable electric grinder. Oct. 28—9 core train cable. Nov. 18—Aerial telephone cable. Nov. 25—Air brake equipment. Dec. 9—Insulated copper wire. Jan. 13—Portable double recording watt meter. Jan. 20—Automatic battery charging equipment.

Victorian State Coal Mine.—Oct. 26—Electric motors. Nov. 25—Cables, junction boxes and switch pillars.

Victorian State Rivers and Water Supply Commission.—Nov. 20—360 B.H.P. quick revolution steam engine and water tube boiler.

GENERAL

Adelaide Steam Ship Co., Sydney.—Oct. 24—Electrical goods.

Broken Hill City Council, N.S.W.—Oct. 31—Alternators, synchroscope and watt hour meters.

Brunswick City Council, Vic.—Oct. 26—500 Ironclad 5/10 amp. house service fuses.

Byron Shire Council, N.S.W.—Oct. 17—Switchgear, lead covered cable, dividing boxes and protective apparatus.

Dandenong Shire Council, Vic.—Oct. 22—Electrical machinery and control gear.

Elmore Electric Light Co., Victoria.—Oct. 30—Crude oil engine or engines.

Launceston City Council.—Nov. 9—3,600 electricity house service meters.

Melbourne and Metropolitan Tramways Board.—Dec. 8—Ten two-motor equipments, air brake equipments.

Melbourne City Council.—Nov. 23—(Extended), 5,000 kw. turbo-alternator.

Newcastle City Council.—Nov. 9—2,300 single phase meters.

Seymour Shire Council, Victoria.—Oct. 24—Crude oil engines and generators.

Shire of Paroo, Cunnamulla, Queensland.—Oct. 31—Power and generating plant, switchboard, poles, cross-arms, cables, insulators, lightning arresters, service cut-outs, portable instruments, street lighting fittings and lamps.

Sydney City Council.—Oct. 19—Copper busbars, two overhead travelling cranes. Nov. 2—Rubber insulated cables, D.C. feeder panels, L.T. underground cables, glazed stoneware bridges, rubber insulated cables. Nov. 16—Tungsten filament lamps. Dec. 4—Insulating tape, impregnated paper tubes, impregnated teak laths. Dec. 14—Hand L.T. switchgear and rotary converters, L.T. pilot cable, H.T. underground cables. Feb. 1—Steam turbo alternator plant. Feb. 8—Steam raising plant. Feb. 22—Power house switchgear.

NEW ZEALAND

Auckland Electric Power Board.—Oct. 19—Cables and earthenware troughing.

Christchurch Drainage Board.—Jan. 5—Three electrical centrifugal sewage pumping plants.

Hastings Borough Council.—Feb. 1—500 B.H.P. Diesel engine, and alternating current generator.

Hawkes Bay Electric Power Board.—Nov. 2—Insulators, copper cables, substation transformers, metering apparatus and feeder switchgear.

Public Works Dept.—Oct. 20—Waikato scheme, lighting arresters; crude oil engine. Nov. 3 (time extended)—Waikato scheme, 110,000-volt transformers. Nov. 24—Two neutral earthing reactors. Dec. 8—Transmission steel supports. Jan. 19—50,000 v. switchgear, section 141. Jan. 26—50,000 v. switchgear, section 139.

Waitemata Electric Power Board.—Oct. 27—Contract No. 11 transformers.

POSITIONS VACANT.

Engineers open for engagement are invited to forward a brief statement of qualifications, experience, salary, etc., to the Editor of this journal for registration.

An electrical draftsman is required by the Broken Hill Pty. Co. Ltd. for the Newcastle iron and steel works. An advertisement appears elsewhere in this issue.

Applications close at noon on Wednesday, Oct. 21, for the position of assistant electrical engineer to the municipality of Young, N.S.W. The salary is £7/5/- per week.

CITY OF BROKEN HILL.**EXTENSION OF ELECTRICITY WORKS**

Tenders will be received by the undersigned up till and including Saturday, the 31st October, 1925, for:

- (a)—Alternators.
- (b)—Motor-driven Pumps.
- (c)—Voltage Regulator.
- (d)—Synchroscope and Watt hour Meters.

Specifications may be seen at the offices of the Town Clerks at Adelaide, Melbourne and Sydney, or obtained from the Town Clerk and City Manager, Town Hall, Broken Hill, from whom all further information can be obtained.

Neither the lowest, nor any tender, necessarily accepted.

J. N. JONAS,

Town Clerk and City Manager.

CITY OF LAUNCESTON CORPORATION.**HOUSE SERVICE METERS**

TENDERS for the supply and delivery of 3,600 Electricity House Service Meters, addressed to "Launceston Corporation," and endorsed "Tender for Electricity Meters," will be received until 4.30 p.m. on Monday, the 9th November, 1925. Particulars from the City Electrical Engineer, Town Hall, Launceston. The lowest or any tender not necessarily accepted.

F. C. CRAWFORD,

Town Clerk.

Town Hall, Launceston, Tas.

9th October, 1925.

THE METROPOLITAN WATER SUPPLY AND SEWERAGE BOARD, BRISBANE.**TO ELECTRICAL LINESMEN**

Owing to poor response previously applications are again invited from competent persons for the position of **ELECTRICAL LINESMAN FOR ELECTRICAL PLANT, SEWERAGE PUMPING STATIONS AND WORKS, PINKENBA AND LUGGAGE POINT.**

Applicants for the position must hold the Certificate of Competency issued by the Electrical Workers' Board, under "The Electric Light and Power Act, 1896," and also Linesman's Certificate. The successful applicant will be required to maintain the 11,000 Volt Transmission Line and also the Board's Telephone Lines between Breakfast Creek and Luggage Point Substations, and in addition take a shift as Electrician if so instructed.

SALARY at Award Rates according to duties.

Applications must state age, whether married or single, and be accompanied by copies only of testimonials and are to be in the hands of the undersigned not later than 12 o'clock noon, on Friday, 16th October, 1925.

Applications to be endorsed on front of envelope containing same. "Application for the position of Electrical Linesman."

By Order,

GEO. JOHNSTON, Secretary.

Office of the Board, Albert Street,

Brisbane, 24th September, 1925.

MUNICIPAL COUNCIL OF SYDNEY.**BUNNERONG POWER STATION—TENDERS FOR STEAM TURBO ALTERNATOR PLANT—SPECIFICATION NO. 954.**

SEALED and ENDORSED TENDERS will be received by the undersigned until 3 p.m. on the 1st February, 1926, for the supply, delivery, erection, testing, etc., of STEAM TURBO ALTERNATOR PLANT for BUNNERONG POWER STATION in accordance with specification No. 954.

SPECIFICATIONS, etc., may be seen, free of charge, upon application at the office of the Construction Engineer, Electricity Department, Town Hall, Sydney, and copies may be obtained from the same office upon payment of the sum of ten shillings and sixpence (10/6) direct into the City Treasury, Town Hall, Sydney, which sum will be refunded upon the receipt of a bona fide tender. The lowest or any tender not necessarily accepted.

TENDERERS please note that they must pay their cash deposit direct into the City Treasury, Town Hall, Sydney, and NOT enclose it with their tender, otherwise it will be rejected as informal.

ROY HENDY, Acting Town Clerk.

Town Hall, Sydney, 11th September, 1925.

MUNICIPAL COUNCIL OF SYDNEY.**STEAM RAISING PLANT**

TENDERS will be received by the undersigned until 3 p.m. on the 8th February, 1926, for the SUPPLY and DELIVERY of STEAM RAISING PLANT in accordance with Specification No. 964.

SPECIFICATIONS and full particulars may be seen at the Office of the Construction Engineer, Electricity Department, Town Hall, Sydney, and copies may be obtained from the same Office by the payment of the sum of ten shillings and sixpence (10/6) direct into the City Treasury, Town Hall, Sydney, which sum will be refunded upon the receipt of a bona fide tender.

The lowest or any tender not necessarily accepted.

TENDERERS please note that they must pay their cash deposit direct into the City Treasury, Town Hall, Sydney, and NOT enclose it with their tender, otherwise their tender will be rejected as informal.

W. G. LAYTON, Town Clerk.

Town Hall, Sydney, 18th September, 1925.





Editorial





STEAM POWER PLANT DESIGN

Since Faraday's discovery in 1831 that electricity could be generated by the movement of a conductor in a magnetic field, great advances have been made in the practice of electrical engineering. But although it is now hardly correct to say that the science of the application of electricity to the service of man is in its infancy, there is room for still further development. If past history is any guide, the future holds possibilities for great changes, both in methods of generation of electrical energy and in the applications of that energy to the performance of useful work. Some of these changes may be revolutionary, others will be effected along established lines. Probably the greatest scope for improvement lies in steam power station efficiency. The enormous heat loss occurring between fuel and electrical energy in even the most modern stations calls for untiring investigation with a view to finding remedies. In this connection it is interesting to note views put forward from time to time by eminent technicians, as to the lines along which advances may be expected.

In a recent article in the *Electrical World*, Mr. B. N. Broido, a New York consulting engineer, deals with various aspects of future developments. The efficiency of steam power stations has been enormously increased in the last two decades, but the author of this article points out lines along which still further improvements are being made. Of late years the tendency has been to gain efficiency by increasing the size both of generating sets and boiler units, but there are indications that the limits in this direction are almost reached. It is necessary, therefore, to concentrate on certain special aspects of power plant design in order to gain further advantages.

At the combustion end one of the most promising fields for practical research appears to lie in the water cooling of furnaces. At the Hell Gate power station, New York, some of the boiler furnaces have been equipped with fin-walls, consisting of water tubes with thin metallic strips welded on both sides, which form a complete metallic wall on both sides of the furnace. In this installation it has been conclusively proved that the water cooling not only reduces the maintenance of the furnace but appreciably increases the capacity of the boiler. There are, of course, limits to the extent of such cooling, as the furnace temperature must not be lowered

to a point that would affect the combustion. A strong point in favor of the water cooling is that, as the outside of the tubes will be at a temperature no higher than that of the steam lines, they need not be better insulated than the latter. This will considerably simplify the setting of the boiler and reduce the price of brickwork and foundations. Another direction in which research is likely to be profitable is along the lines of the recovery of waste heat from flue gases. In this direction the air preheater shows possibilities considerably in advance of those of the economiser, particularly where cooled furnace walls are used. It has been found in practice that the actual increase in boiler efficiency resulting from the installation of preheaters is greater than the theoretical, due to the improved combustion, especially with low grade coals. Another direction for investigation is into the greater use of radiant heat in boiler furnaces. Pulverised coal, also, has possibilities for improving efficiency.

With steam turbines efforts in the past have been directed towards increasing the temperature range of the steam, i.e., increasing the temperature at which heat is absorbed and lowering that at which it is rejected. In this direction there are limits imposed by the nature of the materials at present in use and the efficiency with which vacuum may be maintained. In order to utilise to the full advantage the high steam pressures available it is necessary to make the high pressure portion of a turbine independent of the other stages, thus many recent designs employ separate high and low pressure turbines. Another advance in thermo-dynamic efficiency has been made by the adoption of feed-water heating by steam tapped off successive stages of the turbine. With surface heating devices there are mechanical limitations to obtaining a perfect regenerative process for feed heating by tapping off a great number of stages. By means of a new piece of apparatus, the Venturi type heater, however, it appears that these limitations will be overcome. In the field of reheating of the steam after it has passed through a few stages there is also room for improvement. The present disadvantage lies in the complication of piping for carrying the steam back to secondary superheaters in the boilers. It is pointed out, however, that live steam may be used near the turbine for reheating.

In addition to researches in these directions there are possibilities along such lines as in the low-temperature distillation of coal, and the use

of mercury vapor instead of steam. These are now undergoing careful investigation, both in the laboratory and under practical conditions. Everything points to continued advancement in steam power plant practice, and to a steady raising of power station efficiency.

MELBOURNE TRAMWAYS CONTROL

The Victorian government has announced that, owing to lack of opportunity to consider the complete reconstitution of the control of the Melbourne tramways, it has decided to extend the term of the present board, which expired on Nov. 1, for another year. In other words, the government has refused to face the situation, notwithstanding an admission that some better administrative system is called for. Manifestly the only proper solution is the creation of a board representing the municipalities, as under the present constitution it is the municipalities, and not the government, which are financially responsible in the long run.

The present board is unpopular with the public, partly because of its policy and partly because it is not representative of the municipalities or the ratepayers. Whilst admitting that its financial position is so serious that huge losses are being incurred, and that next year a special municipal rate to cover the deficit will have to be imposed, the board is light-heartedly embarking on the conversion of the cable tramway system at a cost which will run into several millions of pounds. Certainly the members of the board are responsible to parliament, but to all intents and purposes the Melbourne tramways are a municipal undertaking and as such the municipalities should have a voice in the election of the members of the board. If they have not any voice in regard to the control of the tramways, neither should the board have any power of rating over the municipalities.

Looking generally at the position it would almost appear as if it is the intention of the government to let the present board go ahead with its conversion works and then, when that has gone too far, to hand the whole system over to the railway commissioners. The railway and tramway situation in Melbourne is peculiar. On the one hand, the suburban railways have been electrified at huge expense, but no new line has been built in the last 20 years. The tramways, on the other hand, have been extended in every direction, not so much as feeders for the railways, but often in direct competition; in other words, large sums of money have been spent unnecessarily. Melbourne's suburban railway service is second to none as far as it goes, and if some of the money being spent on tramways had been expended on additional railways, including a new metropolitan station, the public might have been better served at a lower cost.

Any proposal to transfer the control of the tramways to the railway department is bound to meet with strenuous opposition, and in the long run there is little doubt that the tramways will revert to the municipalities. As there is small prospect of a Greater Melbourne Council being formed, the only form of controlling authority seems to be a board elected by the municipalities. There is no reason why such a board should not function efficiently so long as the administration is placed in the hands of a tramway man with the necessary technical knowledge and experience. It is hopeless to expect efficiency in such a field from amateurs.

CONTROL OF MELBOURNE ELECTRIC SUPPLY

The franchise under which the Melbourne Electric Supply Co. has been supplying energy to the greater part of the Melbourne suburban area expired on Nov. 12. The Victorian government has entered into an agreement with the company whereby it will continue to operate under limitations, up to a maximum period of ten years. This agreement has been confirmed by an act of parliament which provides that certain activities of the company are placed under government supervision, which means that the undertaking is under partial control of the state electricity commission. The company must maintain its plant in good order and condition, and may not make any extensions without the consent of the commission; it may not enter into any further contracts for the supply of energy to undertakers without the commission's consent, and it must take any further supply it may require from the commission; it must proceed with the conversion of its system from single phase to three phase as directed by the commission, by means of money lent without interest by or at the instance of the government; its tariffs are subject to the control of the commission, and it is limited in the dividends it may pay to shareholders. All these several points are designed with a view to protecting the public interest while giving the company proper opportunity for winding up its affairs.

The most important point about the agreement between the government and the company, however, is that the government, represented by the electricity commission, will purchase the undertaking at the end of the ten years, and that it has the option of making the purchase at the end of five or seven and a half years. Such a consummation is in accord with the policy of the commission, which aims at obtaining complete control of the generation, distribution and retailing of electrical energy throughout the state. Indeed, the commission appears to be making preparations for the exercise of its option at the earliest possible moment, i.e.,

the end of the five-year period, and evidently considers it a foregone conclusion that the supervisory control of the undertaking, which it at present exercises, will pass into absolute control.

But there is one point yet to be taken into account. Provision has been made in the act that if, within twelve months of the date of sale of the undertaking to the government, a statutory corporation, such as a Greater Melbourne council, be formed to undertake metropolitan public works, the government shall give consideration to the claims of that corporation to the right of distributing electrical energy. This clause has been inserted in deference to the expressed opinion of the municipalities that electrical distribution is a municipal function. Of course, it is out of the question for each municipality in the metropolitan area to undertake distribution in its own district, as this would result in overlapping of effort and lack of uniformity. As matters now stand, the electricity commission is not justified in assuming that the distribution system of the Melbourne Electric Supply Co. is certain to pass into its hands. It will be admitted that the weight of evidence bears in this direction, but nevertheless the municipalities have six years at their disposal in which to form a representative body. Their recent failure to come to an agreement on the question of the formation of a Greater Melbourne council is no reason against the possibility of arriving at an understanding in the future, particularly with such a goal as the control of electricity supply in view. The chief difficulty confronting the municipalities lies in the fact that the electricity commission is the adviser of the government whose assent would have to be given for the united councils to take over the distribution system.

The original conception of the functions of the electricity commission, viz., that it should generate electrical energy and regulate the distribution to consumers through municipal and other undertakings was undoubtedly a sound one. The commission's powers, however, have been so widened that it is now supplying energy retail in dozens of municipalities, and the logical conclusion is that, in the long run, there will only be one electricity supply undertaking in Victoria. Such a scheme has never been attempted anywhere in the world; it is too huge and cumbersome ever to be efficient. Already the commission is in trouble with some of the municipalities whose undertakings have been taken over. The local interests have been eliminated; now everything has to be referred to Melbourne. This is one of the matters about which the expert who is to report to the government on the operations of the commission will have something to say. It would not be surprising if this expert recommends that even at this stage the commission should limit its operations to the generation

of electrical energy and the distribution of such energy by high tension lines for sale in bulk to retailing undertakings, municipal or otherwise. So far as the area served by the Melbourne Electric Supply Co. is concerned, it is fortunate that there is still time for the municipalities to give serious consideration to the formation of a metropolitan electricity supply board, which, in the absence of a Greater Melbourne Council, would probably provide the best solution.

Notes and Personals

Mr. Charles S. Jeffrey, has been appointed assistant state electrical engineer of N.S.W., in succession to Major R. V. Morse, deceased.

The Greater Brisbane council has arranged to install electrical fittings on the time payment system for consumers on its supply system.

Mr. C. A. Magrath has been appointed chairman of the hydroelectric power commission of Ontario, Canada, in succession to the late Sir Adam Beck.

Mr. Talbot B. Wardley, engineer in charge of the Dunmunkle shire power station at Minyip, Vic., has tendered his resignation to take effect on December 9.

Mr. H. P. Slipper, general manager in Australia for Messrs. Siemens Bros. and Co. Ltd., returned recently by the Osterley from a trip to Great Britain.

Professor P. Powell, head of the school of engineering, Canterbury college, has been appointed secretary for New Zealand of the American Institute of Electrical Engineers.

Mr. S. M. Williams, of Coraki, has been appointed electrical engineer to the Kyogle shire council, N.S.W., in place of Mr. K. W. Noonan, who has resigned and leaves shortly for New Zealand.

Mr. E. H. Sharpe, Australian representative of the Chloride Electrical Storage Co. Ltd., Manchester, England, who has been on a visit abroad, returned to Sydney by the Aorangi on October 18.

Mr. C. M. Longbottom, a graduate of the university of Queensland, and holder of a Walter and Eliza Hall travelling fellowship, has been appointed an assistant engineer in the New South Wales railways and tramways department.

Mr. W. H. Gregory, of the Melbourne office of the Australian General Electric Co., has received an appointment as assistant electrical engineer in the public works department of New Zealand. Mr. Gregory, who has been a frequent contributor in these columns, had considerable experience with the Ontario hydroelectric power commission.

An extension to the Melbourne electrified railways, giving service to the outer-suburban district of Fern Tree Gully, was opened on Oct. 12. A much faster and more frequent service is provided by electric traction than was available with steam locomotives.

The annual conference of the Electric Supply Association of Australia will be held in Melbourne during the week commencing Nov. 16. The association comprises the managers of the principal electric supply undertakings throughout the Commonwealth.

The Commonwealth P.M.G.'s department has installed relay repeaters on the Adelaide-Darwin iron telegraph circuit, and Gulstead relay repeaters on the copper circuit at Powell Creek. As a consequence a speed of 80 words per minute is now obtainable between Adelaide and Darwin.

The wiring regulations of the state electricity commission of Victoria, which were published in provisional form last year, have now been confirmed and gazetted with certain slight amendments. All installations in the state of Victoria, therefore, must now be carried out in accordance with these rules.

An extensive overhaul and reconstruction of the Melbourne-Adelaide telegraph and telephone system is to be put in hand. The present lines are inadequate for the volume of traffic and much of the plant and material is old. It is intended, ultimately, to install the carrier wave system of multiple simultaneous transmissions.

A considerable amount of work is being carried out in the provision of adequate and efficient tramway transportation in Brisbane. Extensions, duplication and reconditioning of tracks are in hand, and a contract has just been placed with the Australian General Electric Co. for the supply of 42 traction motors for new rolling stock.

Following on the successful use of a flood light at the intersection of Goulburn and George streets, Sydney, in the regulation of traffic, the Sydney city council has decided upon a further experiment at the George and Market street crossing. Should results prove satisfactory it is proposed to install flood lights in all central city streets.

The Melbourne tramways board has put into service the new electric tram line running from Princes Bridge, Melbourne, through South Melbourne to the Esplanade at St. Kilda beach. The line is four route miles in length and the through fare will be 4d. This line should relieve the congestion on existing transport facilities to St. Kilda during the summer months, as well as providing a more adequate service than that given by motor buses during the conversion of the St. Kilda road cable tramway to electric traction.

Mr. A. O. Glasse has been appointed chief engineer to the Auckland, N.Z., power board. Mr. Glasse joined the board only five months ago as assistant engineer. He is a Dunedin man, having received his early education and training in Otago. Twelve years ago he went to England and joined the British Thomson Houston Co., at the headquarters, Rugby. On the outbreak of war he joined the British section of the New Zealand Expeditionary Force and saw active service with the New Zealanders for the entire period of the war. On his return to England he resumed his duties with the British Thomson Houston Co. and received a good deal of experience on some of the large electrical undertakings in London and the Midlands. He came out to New Zealand for this company three or four years ago to superintend the erection of certain plant for the Auckland city council.

ELECTRICAL WORKERS' BOARD, QUEENSLAND

Examinations for certificates of competency under the electrical workers' act, Queensland, will be held as follow:—Electrical fitters, Nov. 24; electrical mechanics, Nov. 25; electrical linesmen and jointers, Nov. 26.

POSITIONS VACANT

Engineers open for engagement are invited to forward a brief statement of qualifications, experience, salary, etc., to the editor of this journal for registration.

TABLES OF ELECTRIC SUPPLY UNDERTAKINGS

In response to numerous enquiries for particulars of electric supply in various parts of the Commonwealth, the Electrical Engineer Tables of Electric Supply Undertakings of Australia have been published. The undertakings in each state are listed separately, and the information given includes the name of the controlling authority, the type and capacity of plant, the distribution system, and the number of consumers. The tables are revised and up to date reprints of those which appeared in successive numbers of the "Electrical Engineer" some months ago, and they will undoubtedly prove very valuable to those having country or inter-state dealings in electrical appliances. More complete information regarding the various undertakings is contained in Tait's Electrical Directory, which also covers New Zealand and contains additional lists of trade information. Copies of the tables are obtainable at the offices of this journal at a cost of 1/-, or for 1/1 posted to any address in the Commonwealth.

Ocean Telegraphy as Influenced by Oliver Heaviside—II.

By M. C. Timms.

The Work of Heaviside

Writing in the year 1887⁶, Heaviside demonstrated that the diffusion or electrostatic theory on which the KR law is founded is not a general theory, but one applicable only to a special case, that of a very long cable, worked at slow speed. Under the conditions it was intended to meet, the diffusion theory has given excellent results. In the words of Heaviside, "Sir W. Thomson's theory of the submarine cable is a splendid thing."

When, however, a different set of conditions has to be met, the special theory is not applicable, and either a general theory, or special modification of such, must be available to meet the new conditions. The new conditions may be brought about by any one or any combination of the following:—

(a) Low resistance, as given by short cable, or specially heavy conductor.

(b) Low capacity, obtained by modification in the dimensions or material of the dielectric, or that of a short cable.

(c) High speed signalling, or what is more or less equivalent, the use of high frequency periodic currents, as in telephony.

The mistake made by certain eminent practitioners, up to within fairly recent years, was that they mistook the special for the general, and not only sought to apply the KR law to short high speed telegraph circuits, but to telephone lines, submarine, underground and even aerial circuits. Such misconception led to extraordinary results. For example, a leading British authority laid down a law that for good speech over aerial copper wires KR must not exceed 10,000. In defiance of this "law" the New York to Chicago line, 950 miles long, was opened for satisfactory commercial telephone traffic during 1892, and had a KR value of 32,000.

Heaviside proceeded to develop a general theory of transmission, which took into account all four constants of the line. He demonstrated that waves transmitted along wires must be electro-magnetic in nature, not merely electric or electrostatic, as was assumed by the diffusion theory. During the course of many years the theory was elaborated and strengthened, in his *Electrical Papers*, collected in two volumes, and *Electro-Magnetic Theory*, two volumes. A third volume of the latter work deals mainly with unguided aether disturbances, and has more bearing on radio telegraphy. In the works referred to he demonstrates that inductance, so far from being a bugbear, as was supposed

very generally, is an actual aid in transmission. It had been observed by post office and other engineers that telephonic speech was improved by increasing the distance between the wires. It was thought by exponents of the electrostatic school that the improvement was entirely due to reduction of mutual capacity, whereas much of the improvement was due to increased inductance. The dual cause of improvement was not appreciated at the time, except by Heaviside and those of his school.

The General Theory

The general theory of Heaviside regards currents in wires as aether waves guided, not conducted, by the wire, in contrast to Hertzian waves which are radiated freely. The guiding is done at a price, that exacted by resistance, and dissipated in heat. A further slight loss is caused by imperfections of the dielectric, or leakage.

Inductance as analogous to inertia, gives momentum to the waves, and assists in rapid transmission. Capacity or permittance is not the paramount enemy, as once supposed. Its large increase may be tolerated, provided resistance be liberally decreased. Attenuation is equivalent to "diminution of amplitude," and less cumbersome. The meaning of distortion is plain. "Make current variations in a certain way at one place. If the current variations at another place are similar, no matter how much attenuated they may be, there is no distortion. The extremest kind of a distortion is to be found on Atlantic cables."

Distortion and attenuation, although different, are intimately connected. Assume a wave of arbitrary shape impressed on one end of a cable, which has different attenuation factors for different frequencies. The fundamental and various harmonics, of which the original wave is composed, will each be subject to a different rate of attenuation. Before reaching the far end of the line, the relative amplitude of the component waves will be so changed that the received wave will bear little resemblance to the original, thus distortion is the result of attenuation.

A wave impressed on the end of an Atlantic cable of ordinary design will only retain its wave characteristics for a few miles; it will gradually tail off, and become a mere diffusion. If the following wave be sent too quickly, its diffusion will more or less overtake that of the first wave, and neither will be readily recognisable on arrival at the distant end. The time which must elapse between signals depends on the resistance of the conductor. (This effect

6. *Electrical Papers*, Vol. 2, p. 119, etc.

is illustrated in Fig. 5.) Drastic decrease of resistance by the use of a great weight of copper will cause the wave region to extend farther from the sending end, and so by leaving a shorter length to be traversed by diffusion, allow the following signal to be sent after a shorter interval. In this way the speed may be increased by increasing the weight of copper.

The rate of increase of speed obtained by the latter means is, however, so small, that the process soon ceases to be economic. Only by causing the wave to traverse the cable from end to end can any drastic increase of speed be obtained. Such a condition can only be attained by adding inertia (inductance) to the circuit.

Where the waves concerned are telephonic, the limiting distance is well defined. The utmost distance to which commercial speech can be transmitted is well within the distance at which the wave degenerates into diffusion. For this reason the longest possible telephone cable is only a small fraction of the length of an Atlantic cable of similar design. By the addition of inductance the telephonic distance may be greatly increased. The crux of the general theory, however, from a telegraph point of view, is the distortionless circuit.

The Distortionless Circuit

Distortion is produced by the unequal attenuation of the component sinusoidal waves, with the result that some of these may cease to exist before reaching the receiving end. In order, therefore, to eliminate distortion, the constants of the cable must be so proportioned that the attenuation factor is identical for all frequencies. Under such conditions, no matter how rapid the rate of signalling, there would be no distortion, for, though the attenuation might be great, it would be uniform, and the received signal would be similar in shape to that sent.

It is demonstrated that the desired condition is attained when $KR = LG$. The significance of this expression will be realised on consideration that in the ordinarily constructed cable the product LG is exceedingly small, such cables having negligible inductance and, being well insulated, exceedingly small leakage. To attain anything like the distortionless condition, with an ordinary type of cable, is impossible, because however small R can be made, K will continue to have great value. When seeking the distortionless condition, the obvious alternative, once KR is made as small as practicable, is to increase either G or L , or both.

Increasing G would increase attenuation, which, within certain limits, would not matter. There are, however, great practical difficulties attached to attaining any great increase of G . No known material is sufficiently much of an insulator, and at the same time a conductor. It has been suggested that artificial leaks should

be inserted in the cable at intervals. There are mechanical and electrical objections to this course, however. In confirmation of the principle, it is a matter of experience that leaky cables, those having incipient faults, are capable of greater speed than those entirely sound. When such a fault has been removed from a cable, the workable speed has been found to be reduced because, though signals were larger, distortion was much greater⁷.

The other alternative, that of increasing L , is likely to have more ready acceptance, and could be carried out were the materials available. By increasing inductance, a much greater approximation to the distortionless condition can be attained, than by merely reducing KR . Inductance thus is of paramount importance, and methods to obtain largely increased values of L , are deserving of great attention from practitioners. Such in outline is the general theory of Heaviside, and the conclusions to which it led.

Reception of the Theory

The general theory of Heaviside received very little attention from those responsible for the design and construction of systems of electrical communication for many years. Some practitioners regarded the exponent of the theory as a dreamer, and treated his proposals more or less with ridicule. Others, while realising the truth of his teaching, regarded the results aimed at as purely idealistic, their general attitude being that the means were not and never would be at hand, by which to attain the desired ends. A limited few turned their attention seriously to consideration of the practical problems involved, and it was in the telephonic sphere that the first developments were proposed and carried out. While in Britain little more than academic interest was aroused in the work of Heaviside, engineers and scientific men on the continent of Europe and in America were carrying out investigations, with a view to at least putting his theories partially into practice.

Continuous Loading

As has already been stated, the idea of utilising the principle of increasing the inductance of the circuit as an aid in transmission was first put into practice in the younger art of telephony. The capacity, resistance and leakage being uniformly distributed throughout the cable, naturally it was concluded that the inductance should be similarly distributed. Various proposals were made, the most practicable one coming from Professor Krarup, of Copenhagen, which was to closely wrap the conductor with a continuous whipping of soft iron wire. As the magnetic flux due to the current forms a tube encircling the conductor, the direction of the lines of force is at right angles to the axis

7. E.g., the Anglo-Danish cable, see "Electrical Papers," vol. 1, p. 61, and "Electro-Magnetic Theory," vol. 1, p. 420.

of the latter. The iron wire being applied with the shortest possible lay, its axis is approximately at right angles to that of the conductor, and thus nearly parallel to the lines of force. Thus the iron wire presents the minimum of magnetic resistance, resulting in a greatly increased flux density, and higher inductance. This plan, known as the Krarup method, or Continuous Loading, was put into application as early as the year 1902 by the Danish telephone administration, and in the following years numerous cables on the same principle were laid, resulting in marked improvement in transmission.

The amount of improvement obtainable by the use of continuous loading, using iron wire of the highest permeability, is, however, very limited. It is estimated that the maximum inductance obtainable by this means is about twenty millihenries per naut loop. As a matter of fact the majority of the cables so constructed had considerably less than this amount.

Coil Loading

Having in mind the small amount of inductance obtainable, by a continuous wrapping of iron wire, Professor Pupin, in America, investigated the possibility of adding inductance by means of coils in series with the cable, inserted at intervals. In a communication to the American Institute of Electrical Engineers, in 1900, he made known the results of his investigations. According to what is known as Pupin's Law, if lumped inductance in the form of coils, be inserted at intervals along the line, at such distance apart that there are at least nine coils per wave, the non uniform cable thus produced will be in practice equivalent to a cable in which inductance and resistance are equally distributed.

Coil loading was early put into practice in the United States on both aerial and underground lines. Its employment in either of these locations is a comparatively simple matter. Coils having very considerable inductance can be supported on pole structures, or located in underground chambers, without difficulty. Owing to the inherent difficulties to be overcome, a number of years elapsed before coil loading was applied to under water cables. A partially successful attempt at Lake Constance was followed in 1910 by a completely successful cable laid by Messrs. Siemens Bros. and Co. Ltd. across the English channel⁸. By means of coil loading, as much as 100 millihenries per naut loop can be added to a submarine cable without difficulty, when laid in comparatively shallow water. There is grave reason to doubt, however, whether such a cable could be successfully submerged in water anything like approaching the depth of the Atlantic, and if submerged, whether such a cable could be successfully repaired.

It may be noted that loading coils for a telegraph cable would be of very large dimensions, having inductance of several henries and placed at long intervals.

Value of Distortionless Circuit

The problem of the distortionless circuit has been exhaustively discussed by H. W. Malcolm⁹, to whom the writer is indebted for most of the examples here given. In the discussion of this subject, it is generally assumed that the actual value of the cable constants is independent of the frequency, which is probably sufficiently nearly the case with any telegraphic speeds likely to be attained.

The objection to the distortionless condition is that even with high inductance, the amount of leakage required to bring about the equality of GL to KR would be so great that the consequent attenuation would be enormous, resulting in signals which no instrument could record. In addition, the insulation resistance would be so low that testing and maintenance of the cable would be difficult.

The distortionless cable will transmit signals at any speed without alteration of shape. Thus the square topped signals in Fig. 5 would be received exactly similar in shape. Such close similarity is not necessary or desirable. The useful speed may be limited by the capabilities of the sending and receiving apparatus; assuming any receiver could be made to respond to the abrupt changes of value indicated by a square topped wave. The square corners would be most certain to be rounded off on reception by the apparatus, so that a certain amount of cable distortion is not detrimental. Provided the constants of the circuit are such that the steady state is approached before the cable is earthed, the only effect will be to round off the signals.

It would appear then, that what Malcolm calls the Quasi Distortionless cable will provide all that is desired, i.e., great freedom from distortion, coupled with reasonable attenuation. This condition, provided sufficient inductance can be added to the cable, could be attained without excessive leakage. Submarine cables are normally very well insulated, and from an engineering point of view, it is desirable that they should remain so.

The Quasi Distortionless Cable

The amount of loadance required to bring about the quasi distortionless condition would depend largely on circumstances. Assuming, for example, that about 100 millihenries per naut can be added to the natural inductance of the core, examination discloses that remarkable results would be obtained.

The theory on which the KR law was founded has no application whatever. An old friend, the silent interval, comes into existence, a reality

8. For this and other similar examples, see "Electrical Engineer," vol. I., p. 451; vol. II., p. 21, etc.

9. "The Theory of the Submarine Telegraph Cable."

this time, not a myth. The new silent interval, or Relaxation Time, as it has been called, has a value:

$$t = \sqrt{KL}^2 = 1. \sqrt{KL} \dots (7)$$

This time represents the phase difference between the sent and received currents, and obviously it disappears when L becomes zero.

The wave has a vertical front of height Cr , and arrives after an interval of time, $t = 1 \sqrt{KL}$. Cr is the received current in microamperes, and its value is calculated from the formula:

$$Cr = 2E \sqrt{\frac{K}{L}} \dots (8)$$

$$\text{where } \alpha = \frac{R}{2} \sqrt{\frac{K}{L}}$$

and E = Voltage of sending battery.

The velocity, v , in nauts per second equals distance divided by time, thus

$$v = \frac{1}{1 \sqrt{KL}} = \frac{1}{\sqrt{KL}} \dots (9)$$

When the current ordinate attains the height C , the remainder of the curve of arrival is almost identical with that of an unloaded cable having the same value of KR . As the inductance adds nothing to the resistance, the final value of the current would be the same in both cases. The meaning of these statements will be better understood by reference to Fig. 6, which should be compared with Fig. 3; both are plotted to the same scale. In Fig. 6 it will be noted that at an interval of time $t = 0.435$ second, the current rises instantly to a value C , which is the received current, as understood, and has a value of 27 microamps. per volt. From the signalling point of view, the vertical portion of the graph is the only portion of interest. The received current, having instantly a value that, multiplied by a normal sending voltage, would readily work a siphon recorder, the contact of the sending key may be made exceedingly short. The ensuing interval being proportionately short, it is fairly obvious that a very high speed of signalling can be attained; in fact, the limit would appear to be set by the apparatus rather than by the cable.

Attenuation of Signals

The progressive attenuation, or loss of height, of the current ordinate along an infinite cable, is illustrated in Fig. 7, which shows graphically that the height of the signal is a function of t . Fig. 8 shows a portion of the same graph on a larger scale, also shows the progress of the reflected wave from the receiving end; the latter wave, it will be noticed, suffers attenuation so rapidly that any further reflection, from the sending end, would be infinitely small.

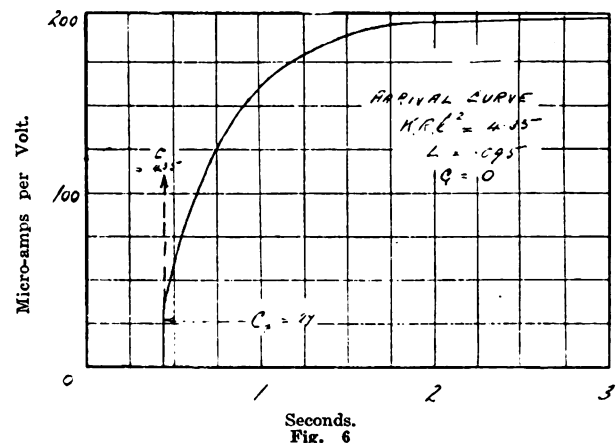
It may be noted that, in the infinite cable, the received current at 2.276 nauts and time $t = 0.435$ sec. is only one-half of that calculated by formula (8). The reason for this is that,

in the finite cable the reflected wave is added to the received wave, and being of the same sign, doubles the amplitude of the latter.

Shape of Signals

Fig. 9 illustrates a dot signal received through a cable exactly similar to that to which Figs. 6, 7 and 8 refer. ($KR^2 = 4.35$. $L = 0.095$) Here are shown dot signals having duration of contact of 0.08 sec. (A) and 0.02 sec. (B). It will be noted that in the case of the contact of longer duration, the tail of the signal, or decay of the charge, is somewhat marked, while in the case of the short contact, the received current is still sufficiently high, and the tail tends to disappear. Could the contact be made sufficiently short, the signal would only rise to the height Cr (where Cr = received current per volt of sending battery) which, when multiplied by the sending voltage, would provide a workable current value, while the tail would be entirely eliminated.

The presence of the tail, or the slow decay of the charge, shown very markedly in Fig. 4,



is one of the principal causes limiting the speed of cables, as it gives rise to much of the distortion. It therefore follows that the shorter the time of contact, the lower the distortion in a loaded cable.

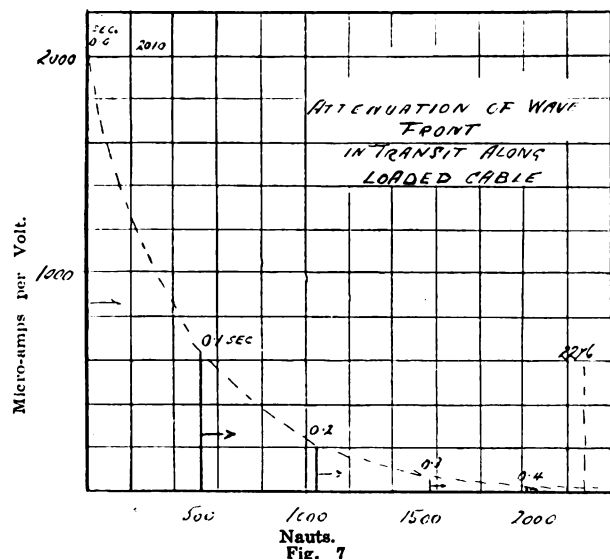
The presence of earth currents would make it necessary that a loaded telegraph cable should be worked through signalling condensers, such as are used in connection with a plain cable. The use of these condensers still further improves the sharpness of signals through the loaded cable. This effect is on all fours with that experienced in the case of a plain cable; the condensers were originally added to block earth currents, but they had what was at the time an unforeseen effect, causing an improvement in the quality of signals, while the decreased amplitude of same was negligible.

From the considerations here noted, it is obvious that the addition of substantial inductance to a long telegraph cable will enormously

increase its traffic carrying capabilities. This is entirely in accordance with the doctrines of Heaviside. These doctrines, which were neglected for so long, have become of late years very fully appreciated, and it only remained for means to be found to put them into practical application. The discovery of these means is one of the incentives for the compilation of these notes.

Methods of Loading

As has been already noted in the brief reference made to submarine telephony, there are two methods of adding inductance to the cable, the Continuous method and the Coil method. Examination of the effect of continuous loading, i.e., wrapping the copper conductor with a layer of soft iron wire, and so obtaining an inductance of possibly 10 millihenries per naut, discloses that no help can be obtained by this means.



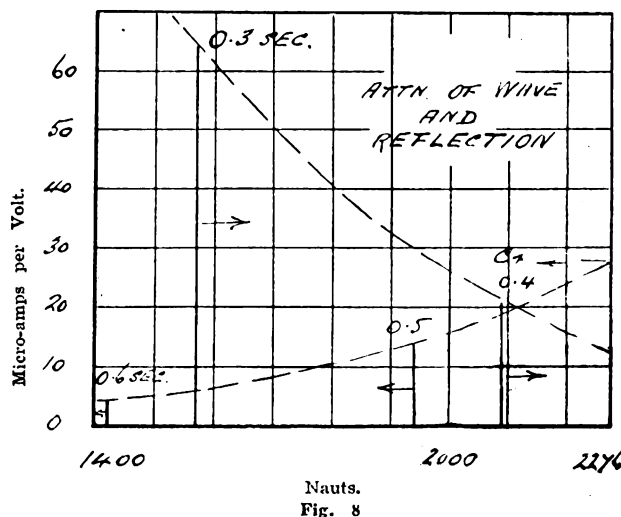
If the diameter, D , of core, and so the cost of same, be kept constant, space for the loadance can only be obtained by cutting down either the copper or GP. If the first course be pursued, the resulting KR will be increased by about 20 per cent, owing to the increased resistance of the lighter conductor. A similar increase of the time constant will ensue if the other course be followed, the final result in either case being a decrease of speed. If the diameter of core be increased so that KR remain as before, about 13 per cent extra GP will be required, and the result will be no better than that obtained from the unloaded cable. It has to be remembered that, from the resistance point of view, the iron will do nothing to compensate for the copper it will displace.

It has been found by experiment that greater improvement may be obtained by the application

of massed inductance at the ends of the cable than is obtainable by loading on the continuous plan with iron wire.

As already noted, in theory, any amount of inductance may be added to a cable in the form of coils, on Professor Pupin's plan, but the mechanical objections to building the necessarily very large coils into a cable to be laid in ocean depths, are such as to make this plan impracticable. Some form of continuous loading, however, would entail no mechanical peculiarities in the cable, and would thus add no hazard to the operation of laying or repairing. Such a cable also would be no more liable to develop defects than is the cable of standard design, as illustrated in Fig. 1.

The inductance obtainable by means of a wrapping of soft iron is limited by the value of the permeability of the material. Were any substance available, having a permeability very much greater than that of iron, a proportionately greater inductance could be



obtained by the same expenditure of material. The need of such a substance has stimulated research, with the result that at least two new alloys are now available as a substitute for iron.

Permalloy

The first of the alloys referred to is Permalloy, the composition of which was discovered in the research laboratories of the Western Electric Co., New York. The patent for this material is owned by the Western Electric Co., from whom supplies are obtained by the users. Permalloy is a mixture of nickel and pure iron, 80 per cent of the former being alloyed with 20 per cent of the latter. The permeability of this alloy is stated to be thirty times that of the best Swedish iron. It is therefore evident that the use of this material as a substitute for the soft iron wire already referred to, provides

ance than has hitherto been possible. 100 millihenries per naut would seem to the writer to be well within the realms of possibility, and, as already shown, this amount of loadance is sufficient to entirely transform the conditions of cable transmission.

Another metal of very high permeability, known as Numetal, is available. So far as the writer is aware, the composition of this substance has not been disclosed, but its permeability is said to be higher than that of Permalloy.

Application

Permalloy as a loadance material for ocean cables has already been put into use. The Western Union Telegraph Co.'s 1924 cable, New York to the Azores, about 2,260 nauts, has a

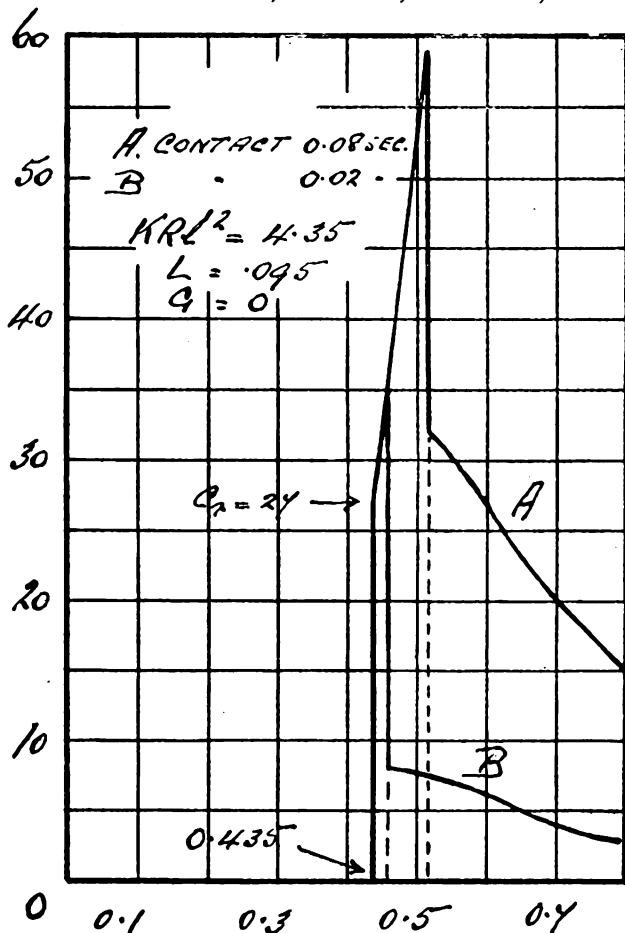


Fig. 6

continuous loading of this material. This cable was opened for traffic early in the present year, and the speed obtained is 1,700 letters per minute in one direction, or nearly six times that obtained through the average ordinary cables. The Commercial Cable Co.'s unloaded cable, laid in 1924, has a total speed of 1,200 letters per minute duplex. The single way speed would be rather more than half this figure. This speed has only been obtained by the expenditure of a very large amount of copper and GP, and it is

still little more than one-third of that obtained through the loaded cable.

Following on the success obtained by the Western Union Co.'s loaded cable, the Pacific Cable Board has ordered new cables for its northern sections, to be loaded in a similar manner. The present cable on the Fanning Island to Bamfield section is the longest cable in existence. A new one for the section, 3,458 nauts, has been ordered from the Telegraph Construction and Maintenance Co., which is using Numetal as the loading material. The Fanning Island to Fiji cable, which has been ordered from Messrs. Siemens Bros. and Co. Ltd., 2,045 nauts, will be loaded with Permalloy. It is expected that the speed of these cables will be many times that of the existing cables between these points, with the result that the traffic facilities for cable communication between Australia and America or Great Britain, will be enormously increased.

The Eastern Extension Telegraph Co. has decided to duplicate its Perth to Cocos Island cable, 1,719 nauts. This cable, which has been ordered from the T.C. and M. Co., will also be loaded, presumably with Numetal.

Effects

The effect of the practical realisation of improvements in the direction pointed out for so long and with such emphasis by Heaviside, has been to render obsolete, not only every other existing Atlantic cable, but every ocean cable of any length that exists. This is, however, only the immediate effect; the final consequence will be a vast and incalculable alteration in the standard of telegraphic communication throughout the world. A revolutionary change has been brought about by the mathematical physicist, supported by the painstaking work of the research laboratory. The prophet and seer of the new order was undoubtedly Oliver Heaviside.

Notes

Received Current.—When the received current of a loaded telegraph cable is referred to, the value calculated from formula (8) is what is meant. Examination of this formula discloses certain characteristics, one of the foremost being that G is totally absent, which indicates zero leakance, or its equivalent, very high insulation resistance. Should this condition not obtain, the loaded cable would be worse, from a traffic point of view, than a plain one, which is in accordance with the telephonic case. For this reason loaded cables must be well maintained.

In addition, it is evident that the lower R is made the better, R having much more effect on the received current than K , because in the formula only the square root of the latter appears. Loaded cables should thus be provided with as heavy conductors as practicable.

The amount of loadance, or value of L , has naturally a critical effect on the received current. It may be noted that the value of the latter, for a cable having 40 to 50 millihenries per naut, is only about one-fifth of that received through a cable loaded with 95 millihenries per naut; thus, halving the loadance reduces the signal strength to one-fifth (K and R being assumed equal in both cases).

The formula given for received current assumes the absence of receiving apparatus. The actual current received will naturally be modified by the apparatus, which should have as low impedance as possible.

Telegraphic Frequency. One of the inherent difficulties which has been found in forecasting the performance of a long telegraph cable, lies in the fact that, if the line is worked at or near its practical speed limit, the steady electrical condition is never attained. Were the steady condition of either continuous or periodic currents closely approached, the powerful agency of hyperbolic trigonometry could be applied, as in the telephonic case, but this is not available when the phenomena concerned are only of the transient variety. Partly for this reason, greater progress relatively has been made in telephonic transmission, because a steady periodic current of suitable frequency can be chosen that sufficiently closely simulates telephonic currents for calculation and testing purposes.

Discussing the possibility of substituting in calculations some form of periodic current, either a train of dots or of reversals, Dr. A. E. Kennelly¹⁰ concludes that the following formulae would give very approximate results.

Train of dots:

$$f = 38.5 \div K R I^2 \text{ pps.} \dots \dots (10)$$

Train of reversals:

$$f = 19.25 \div K R I^2 \text{ pps.} \dots \dots (11)$$

These formulae are based on the empirical formula of Jacob (4), also on an estimate that the average five letter word contains 38 five-dot elements. It is generally considered, and the writer thinks reasonably, that the train of reversals most effectively represents the conditions or actual signalling, and therefore formula (11) should be adopted, when applying alternating current theory to the submarine telegraph cable.

Loading Coils.—Emphasis has been given above to the impracticability of embodying inductance coils in cables to be laid at ocean depths. It must be understood that the intensity of any difficulty is necessarily comparative. It is possible that under extraordinary stress of circumstances, efforts would have been made to use coil loading in long telegraph cables, but the necessity would have been very great to have made the inevitable risk and difficulty commercially worth while. In any case, the discovery of alloys, having an enormously greater

permeability than iron, has definitely relegated to the background the desirability of loading coils.

The Nature of Cable Signals.—Cable signals are universally such as could be received on the Kelvin syphon recorder, though in important stations, they are, when received, automatically converted into Morse, and read in that form. The syphon recorder is in effect a centre zero recording microampere meter, and it plots a record of the received current on a paper tape

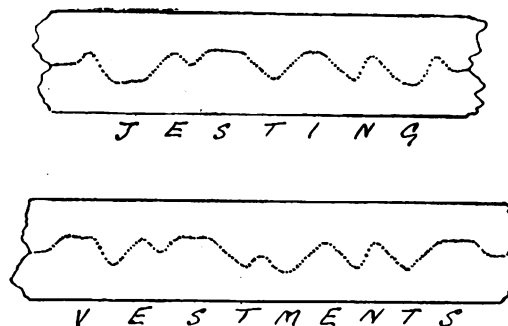


Fig. 10

or slip. The moving coil of the instrument is harnessed to a slender syphon tube, one end of which is submersed in an ink reservoir; the free end of the syphon tube is centred very lightly on the paper tape, on which, when at rest, it draws an approximate straight line, the paper being drawn along under it. In order to minimise friction, a slight trembling motion is imparted to the syphon.

When, on excitation by a current from the cable, the coil deflects, the syphon follows its motion, and produces a wave on the ink line, on one or other side of zero, depending on the direction of the current. A wave above the line being regarded as a dot, or one below as a dash, the necessary combination of both to produce letters of the Morse code, can be made

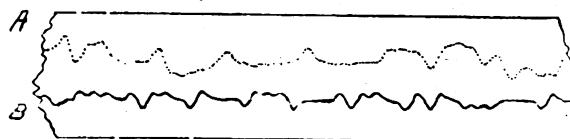


Fig. 11

by impressing suitable reversals on the sending end of the cable by means of a hand key, or automatic sending apparatus.

The Eastern Extension Telegraph Co.'s Sydney, N.S.W., to Wellington, N.Z., cable has a $K R I^2$ value of 6.0. (There are actually two such cables.) Inserting this value in Jacob's formula (4), $(120 \div 6 = 20)$, gives 20 five-letter words per minute as the commercial speed of such a cable. The author is indebted to friends in the company for Fig. 10, which shows the words "jesting" and "vestments," as received in

Sydney from Wellington, through the cable referred to, at a speed of 100 letters, or 20 five-letter words, per minute. Examination of this diagram demonstrates that considerable skill is required to interpret signals sent through long cables at commercial speeds.

Cables are always worked "duplex," that is to say, messages are sent and received simultaneously, thus nearly doubling the carrying ability of the line. The sent and received signals are sometimes recorded on the same slip side by side. Fig. 11 shows specimens of sent and received signals through a cable having KRI² value of 8.2, at a speed of 18 five letter words per minute. The difference in definition between the signals as impressed on the cable, and as received from it, is sufficiently marked to be evident to the most casual observer.

ERROR

In Part I of this article, in the October issue, p. 261, last line of second column, formula should read $t = 0.25\sqrt{d}$.

CONFERENCE OF HIGH TENSION SYSTEMS

The third session of the international conference of large electric high tension systems was held in Paris from June 16 to June 25, inclusive. Representatives of electric supply authorities and electrical institutions from all parts of the world were present. Australia was represented by Messrs. F. W. H. Wheadon, A. Maughan, E. C. Barton, A. U. Alcock, and R. G. Crivelli. The work of the conference is divided into three sections: (1) Power production, including the construction of large central power stations, alternators, transformers, substations and high tension apparatus; (2) Construction of lines, including calculation and construction of line supports, attachment of conductors, insulators, overhead conductors, underground cables, etc.; (3) Working of systems, including the working of central power stations, parallel operation of stations and systems, safety precautions, protection of apparatus, lightning arresters, communication between stations, government regulations, etc. All the various questions are studied from the technical, social, administrative and financial points of view.

At the recent session 112 reports on the different subjects were dealt with. The reports were not read at the meetings, only a brief resume being given, but verbatim transcripts were available to the delegates. With such a wide field to cover, time would not allow of detailed consideration, and therefore only the important points could come up for general discussion. Some of the subjects reported upon and discussed were as follow:—The relative advantages of overhead lines or underground cables for power transmission; rural distribution

of energy; the exchange of energy between central stations; transmission line supports—steel, reinforced concrete and wood; improvement of power factor; influence of high tension lines on lines of tele-communication; the construction of alternators; the draft and heating of boilers; government regulations for the erection of high tension lines. Reports were also received giving practical experience in the solution of technical problems, such as on the working of underground cables on voltages as high as 130,000 between phases. The full text of the work of the conference will be published in two volumes with a total of perhaps 2,200 pages.

Amongst the important resolutions passed was one that a model form for statistics of the production, transmission and distribution of electrical energy, usable on the same basis in all countries, be drawn up. Others recommend such action as the drawing up of a standard specification for switch and transformer oil, and of international regulations for the supply and acceptance of insulators. Apart, however, from any resolutions passed, the conference has great value from the interchange of ideas which it promotes. Mutual assistance is given in the solution of problems, and the conditions obtaining in widely separated regions are compared. The next session will be held in Paris in June, 1927.

A.G.E. CONFERENCE

The third annual conference of the Australian General Electric Co. Ltd., and its agents, was held at the Hotel Australia, Sydney, from Oct. 12 to Oct. 16, inclusive. Mr. A. Maughan, the Australasian manager, who recently returned from a tour abroad, presided. Addresses were given as follow:—Customs regulations, Mr. C. G. Seeley; radio in Australia, Mr. H. Leverrier; new and special apparatus, Mr. J. L. Booth; heavy duty cooking equipment, Mr. C. W. Rofe; G.E. wiring devices, Mr. P. G. Scott; stock control, Mr. R. D. Sinclair; arc welding, Mr. C. W. Wright; printing press equipment, Mr. A. M. Brown; electro-magnetic tools, Mr. N. R. Johnston; Willard batteries, Mr. R. T. Gepp; the direct metallic resistor in electrical industrial heating, Mr. L. H. Nutter; erection of heavy machinery, with special reference to the White Bay power house, Mr. A. R. Bowell; opening a branch office, Mr. S. B. Cox; joint manufacture in relation to large contracts, Mr. F. B. Clapp. Opportunity was taken of entertaining the visitors at dinner on the evening of Oct. 13, and a dance was provided on the following night. A visit to the White Bay power house and automatic and manual substations concluded one of the most enjoyable and successful functions yet held.

The Connection of Single Phase Transformers for Three Phase Operation

By W. H. Gregory*

Operating engineers on power supply systems are often called upon to solve problems in the arrangement and connecting up of equipment in their charge. With the extending use of a.c.

transformers, having either subtractive or additive polarity, are connected to a three phase bus so

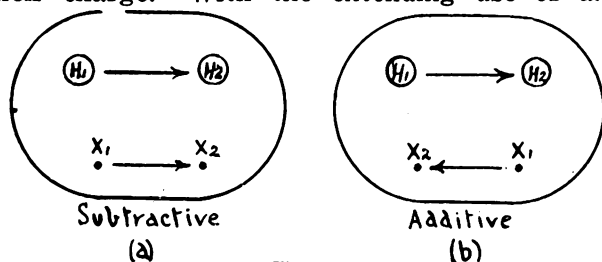
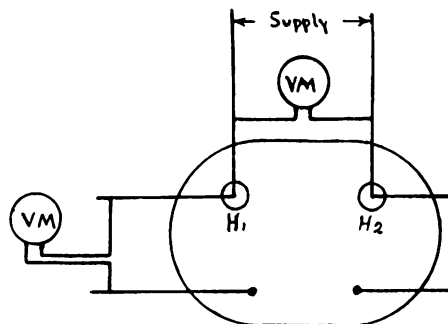


Fig. 1.

distribution systems in modern practice, an increasing number of these problems have to do with transformers, involving such matters as the connection of three phase transformer banks, made up of single phase units, for parallel



that the polarity, phase rotation and angular displacement are the same as those of an existing three phase unit.

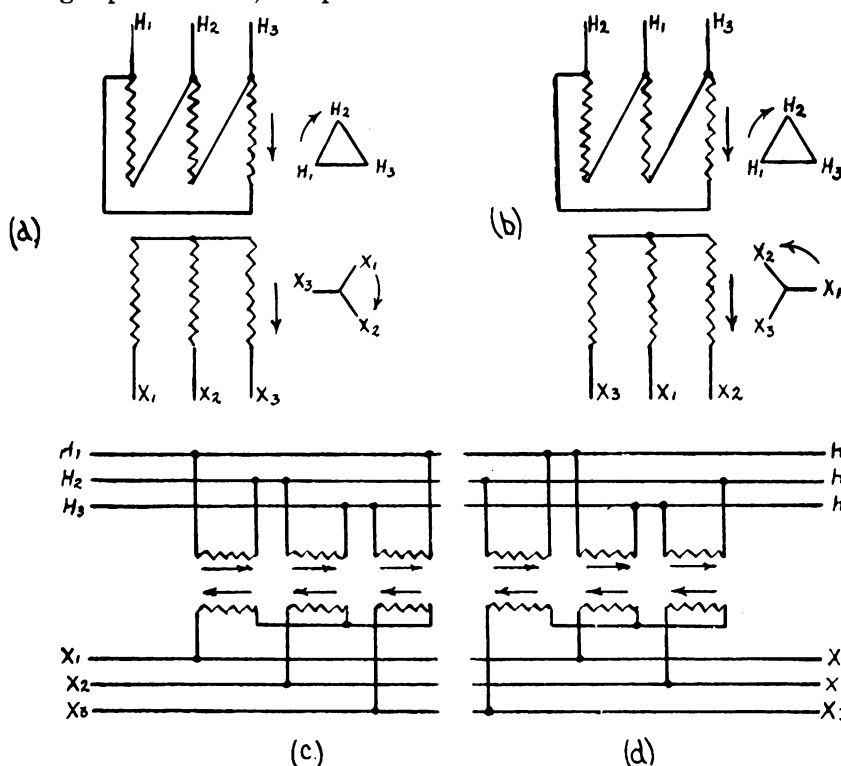


Fig. 3

operation with existing three phase transformers. In many cases there has been complete lack of knowledge of how the problem of connecting single phase units (which form a three phase bank) to the three phase bus should be approached. It is the purpose of this article to discuss several cases where single phase trans-

formers, having either subtractive or additive polarity, are connected to a three phase bus so that the polarity, phase rotation and angular displacement are the same as those of an existing three phase unit.

*Public Works Dept., New Zealand

voltage current to the high tension terminals, and measuring the voltage across the high tension terminals H1 and H2, and across the open high and low tension terminals (Fig. 2). If the voltage measured across H1 and H2, is greater than that across the open high and low tension terminals the polarity is subtractive, while if the voltage across the open high and low tension terminals is the greater the polarity is additive. When the polarities of the single phase transformers are known the units may be connected to the three phase bus to suit any three phase polarity, phase rotation and

the standard connection, and b the transformer with the connections reversed, which amounts to a change of connections to the three phase bus. This is shown also by the three single phase units in c and d, where c corresponds to a and d to b. From these it will be readily seen that the change in the diagram is due to the phase rotation of the supply, which is taken to be in the time order of $H_1-H_2-H_3$ on the high tension side, and in the time order of $X_1-X_2-X_3$ on the low tension side. The star-star or delta-delta connected transformer, having two of the external connections changed on the

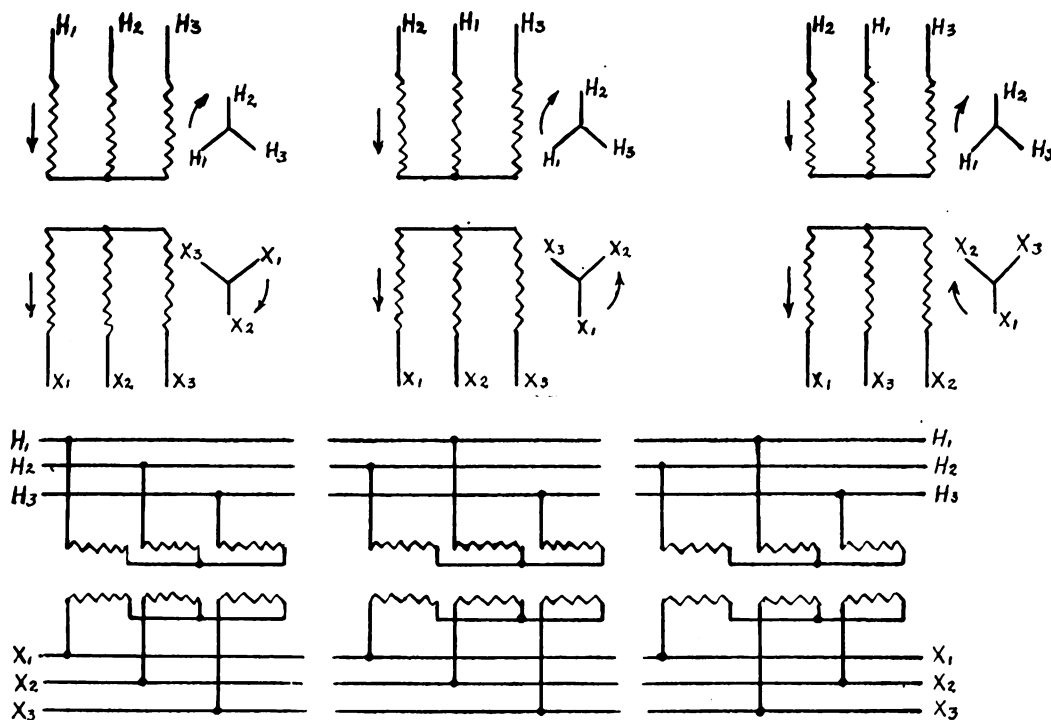


Fig. 4

angular displacement of the existing banks, provided that the new transformers comply in every other respect for parallel operation.

It may be well at this point to mention that the polarity and angular displacement of star-star or delta-delta transformers cannot be changed by altering the external connections or lettering, the only effect of so doing being the changing of the lettering on the voltage diagrams. Thus if a new three phase unit is connected so that its polarity, phase rotation and angular displacement are not the same as those of the existing units, the internal connections should be changed to give the desired results. In dealing with transformers that are connected star-delta or delta-star, the polarity phase rotation and angular displacement may be changed by changing over two of the incoming and outgoing lines as shown in Fig. 3. Here a shows a delta-star connected transformer with

high tension side only, changes not only the lettering of the diagram, but also the phase rotation on the low tension side, the diagram otherwise remaining the same. Where the connections are changed on both high and low tension sides, the phase rotation remains the same while the lettering only of the diagram is changed. This is shown in Fig. 4, where the three conditions are illustrated by three phase transformers and their equivalent single phase units.

First consider the connecting of single phase delta-star transformers with polarities as follow, forming a three phase bank, to parallel with an existing three phase transformer or three phase transformer bank:—

- (a) All units additive,
- (b) All units subtractive,
- (c) Two additive and one subtractive,
- (d) One additive and two subtractive.

Fig. 5 shows the connections to the three phase bus for the above four cases, so that the polarity, phase rotation and angular displacement of each bank correspond to those of the existing three phase transformer. The instantaneous voltages in both windings of each transformer are shown by the arrows. It will be found in all four cases that the following reasoning holds

ment. In these cases the following reasoning applies for making the connection to the buses for both banks of transformers:—

H_1-H_2 is parallel to and in the same direction as X_2-X_1 .
 H_2-H_3 " " " " " " " " X_3-X_2 .
 H_3-H_1 " " " " " " " " X_1-X_3 .

It is a good point to remember in making delta connections that if a current is made to

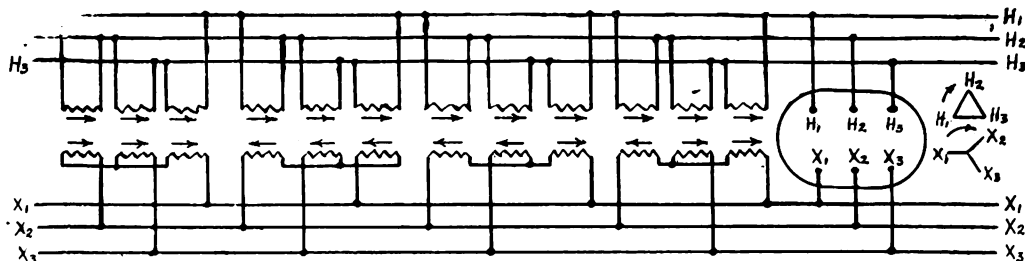


Fig. 5

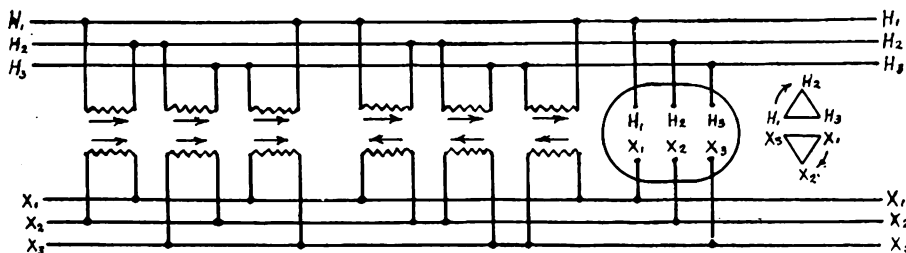


Fig. 6

Three Phase Transformers			
Group 1 Angular Displacement 0°			
Group 2 Angular Displacement 180°			
Group 3 Angular Displacement 30°			

Fig. 7

good for making the connections to the three phase buses:—

H_1-H_2 is parallel to and in the same direction as $n-X_2$.
 H_2-H_3 " " " " " " " " $n-X_3$.
 H_3-H_1 " " " " " " " " $n-X_1$.

Fig. 6 shows the connections to the three phase bus for two banks of single phase delta-delta transformers of additive and subtractive polarity respectively, in parallel with an existing delta-delta connected transformer having standard phase rotation and 180 deg. angular displacement.

circulate within the delta the current flow will always be in the same direction in the three windings; this will help in checking the correct connections.

The A.I.E.E. has adopted a standard system of three phase transformer connections, the voltage diagrams of which are shown in Fig. 7. The general practice of transformer manufacturers is to put forward transformers having any one of these connections, unless the customer specially asks for a transformer with a non-standard voltage diagram to parallel with an existing transformer. Figs. 8, 9, and 10 show various connections to the three phase buses for transformer banks, consisting of single phase units of additive and of subtractive polarity, giving the voltage diagrams shown in groups 1, 2 and portion of group 3, Fig. 7. It will be noted that the arrows indicating the instantaneous induced single phase currents across the high and low tension terminals, also indicate the directions of the currents in the high and low tension voltage diagrams with respect to each other. Thus in making up a specified connection the voltage diagram of the existing transformer may be used. The method employed is to make each line of the voltage diagram represent a winding of the transformer to be connected. Then, knowing the polarity of the transformer being used, it is an easy matter to work out the connections required to suit any existing transformer bank having a certain

polarity, phase rotation and angular displacement as indicated by the voltage diagram.

As an example consider a delta-delta connected transformer with voltage diagram as shown in group 1, Fig. 7, and connect three additive polarity, single phase transformers in parallel with same for the same voltage diagram.

Transformer	1	2	3
Connections to high tension bus	H_1-H_2	H_2-H_3	H_3-H_1
Single Phase h.t. terminal lettering	H_1-H_2	H_1-H_2	H_1-H_2
Connections to low tension bus	X_1-X_2	X_2-X_3	X_3-X_1
Single Phase l.t. terminal lettering	X_2-X_1	X_2-X_1	X_2-X_1

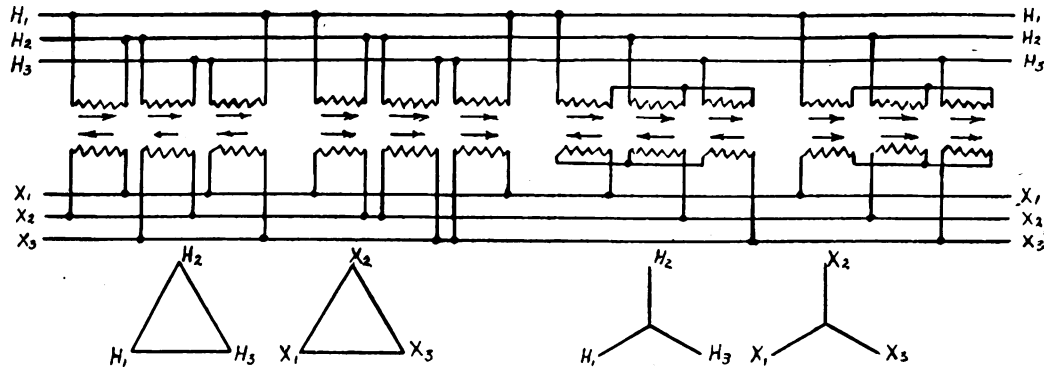


Fig. 8
Group 1. Angular displacement 0 deg.

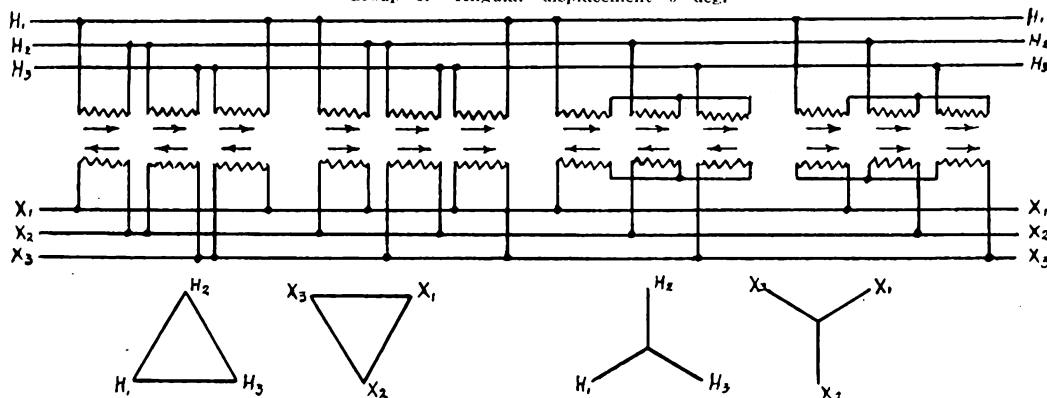


Fig. 9
Group 2. Angular displacement 180 deg.

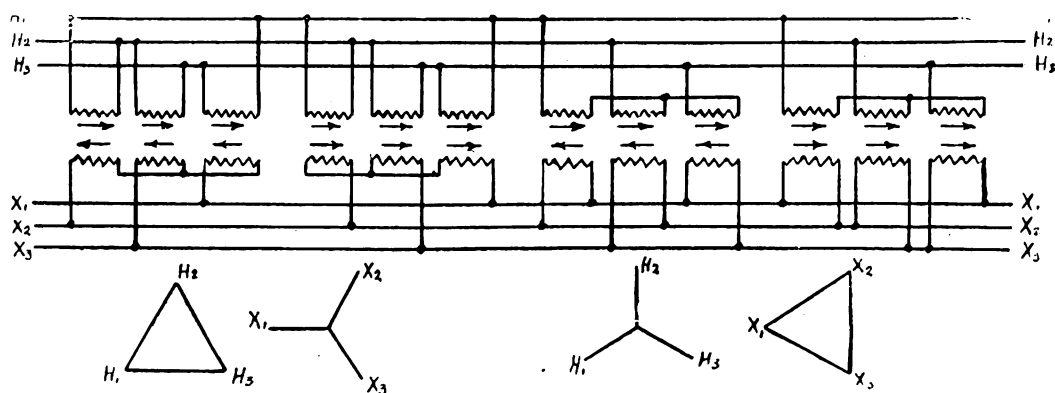


Fig. 10
Group 3. Angular displacement 30 deg.

The phase rotation being in the time order of $H_1-H_2-H_3$ on the high tension side, and $X_1-X_2-X_3$ on the low tension side, and the single phase transformers being of additive polarity, the connections to the high and low tension buses are made as in the following tabulation:—

It must be noted that the connections are made to the three phase buses so that the instantaneous induced currents are in the direction indicated by the individual lettering for each transformer, as shown in Fig. 8, i.e., in the direction H_1-H_2 on the high tension side, and X_1-X_2 on the low tension side. This

applies to single phase transformers of like and unlike polarity. The above reasoning stands for the connections and voltage diagrams shown in Figs. 9 and 10, and also for any system of connections that may be required to suit specified conditions.

It might be appropriate at this point to include a few remarks on the practice of marking the incoming and outgoing lines to and from the transformers. The incoming lines are called Red, White and Blue from left to right, facing the high tension entrance bushings, with back to the source of power. Thus, the color of the incoming line fixes the color of the transformer, and the color of the transformer fixes the color of the low tension phases, so that it will be seen that the following holds good for star and delta connected transformers:—

If h.t. is star connected—

Red transformer is one connected to red phase.
White " " " " white "
Blue " " " " blue "

If h.t. is delta connected—

Red transformer is one connected to red-white phases.
White " " " " white-blue "
Blue " " " " blue-red "

If l.t. is star connected—

Red phase is one connected to red transformer.
White " " " " white "
Blue " " " " blue "

If l.t. is delta connected—

Red phase is one connected to red-blue transformer.
White " " " " white-red "
Blue " " " " blue-white "

Much more could be written on this phase of transformer practice, but if the above instructions are carefully noted and carried out, there should be no need to fear the making of any connections to suit a specified voltage diagram.

Electricity in a Farming Area

The Tyers District Scheme of the Victorian Electricity Commission

Electro farming schemes need careful consideration from the point of view of the supply authority, because unless special means are adopted to keep down the capital cost, the comparatively low revenue possible of collection from what is usually a mere handful of con-

sumers in sparsely populated districts at rates that are attractive to the farmer and at the same time show a margin for revenue over expenditure.

The Victorian electricity commission is now supplying several farming communities in its

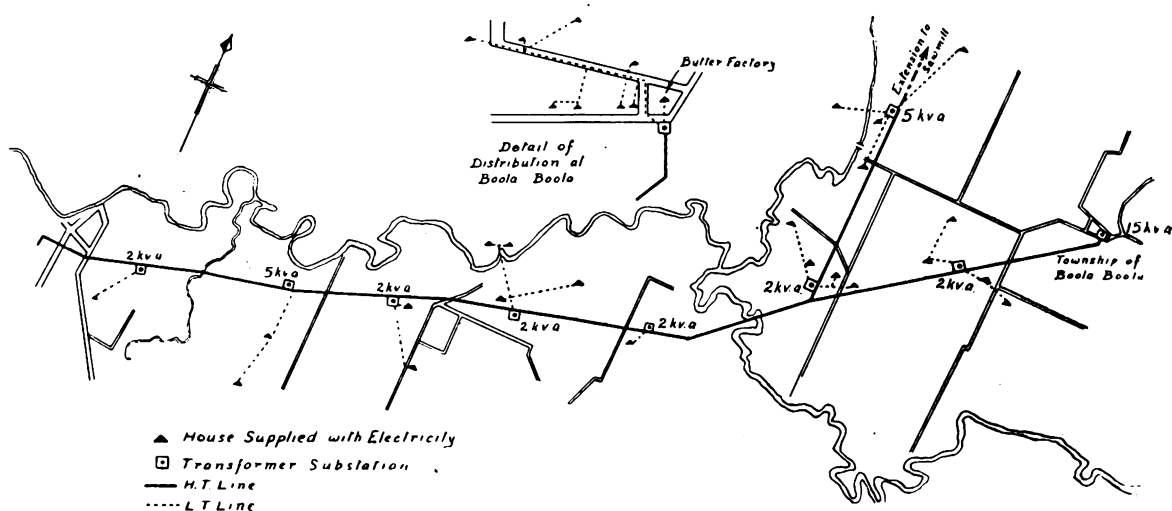


Fig. 1. Tyers District Distribution

sumers, will be insufficient to pay operating charges and leave a sufficient margin to pay capital charges. Extensive experiments with a view to ascertaining the economic possibilities of electric supply in rural areas are being carried out in many parts of the world. From what has been achieved up to the present it appears that, with the exercise of rigid economy in the use of material, it is possible to give

main transmission areas. The first of its farm supply schemes to be inaugurated is that in the Tyers river district, near Traralgon, Gippsland. It was developed entirely as a supply to farmers, and was put into operation in October, 1923. The energy is supplied by means of a 6,600-volt single phase transmission line from the commission's main power station at Yallourn. As will be seen from Fig. 1, the line is so

located as to serve the various consumers with a minimum of reticulation. The main line is divided into two branches: one terminating at Boola Boola township, and the other running north to the Tyers sawmill. The total length of 6,600-volt line is $8\frac{3}{4}$ miles. The line is designed for three phase supply, with delta pole top construction, but is at present operating single phase. Only two conductors have been strung, and these are of aluminium, steel reinforced, of 0.0657 sq. in. section. Wooden poles 35 ft. in length are used, and the normal span is 400 ft.

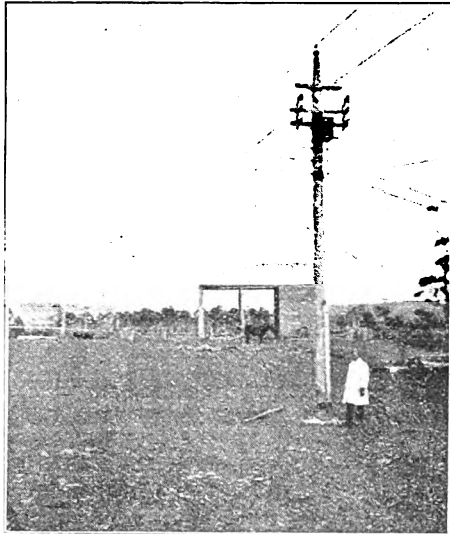


Fig. 2. Pole Type Transformer Station

The various farm groups are supplied through pole type transformer stations. There is a 15 kv.a. station at Boola Boola township supplying the butter factory and adjacent consumers. At intermediate points along the line, as shown in the plan, are two 5 kv.a. and six 2 kv.a. transformers. At the Tyers saw mill, about three miles from the tee off, is a further substation, supplying energy to a 60 h.p. three phase motor running single phase. This, however, can hardly be regarded as part of the actual farm supply system, although, of course, the presence of such a load is of great assistance. In each case the substation is located as nearly as possible in the centre of the load group. The transformers at the intermediate loading points are mounted on the h.t. poles, being hung from crossarms as shown in Fig. 2.

The low tension distribution is carried out at 460/230 volts, on the three wire system. The lines are constructed with 30-ft. poles at an average spacing of 250 ft. Copper conductors are used, in sizes varying from 7/.083 to 7/.044. In order to keep costs to a minimum each line was built to serve as many consumers as possible. Figs. 3 and 4 illustrate forms of con-

struction adopted for the sake of economy. The former shows a section of the h.t. line in which the poles are used also to carry l.t. conductors. This, of course, necessitates the use of the shorter spacing. The latter illustration shows a cheap l.t. line pole, made by merely lopping a tree that happened to be growing in the right position. This pole stands on a hill and carries one end of a 600-ft. span across the adjacent valley. In addition it is used as a service post for the farm in which it stands.

The labor for erecting the low tension lines was supplied by the farmers receiving service,

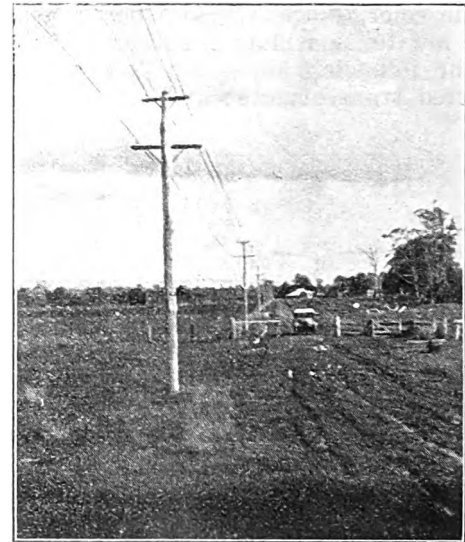


Fig. 3. H.T. and L.T. Lines carried on same Poles

the electricity commission supplying the material and providing technical supervision. An agreement was signed by each party to the scheme, authorising a committee, known as the Tyers electric light committee, to erect the low tension lines. The actual cost of service line averaged £33 per consumer. Under the scheme each farmer was required to guarantee a minimum annual payment to the commission of £10 for energy consumed.

Applications of Electricity

That the provision of electric supply to the farmers has been appreciated is shown by the fact that over 90 per cent of the Tyers district farms within distribution radius are at present connected, making a total (including the sawmill) of 31 consumers. The summary of the connected load, given in Table I., shows the diversity of use for the electrical energy.

Amongst the various duties performed by the motors installed are, milking, separating, butter making, chaff cutting, corn crushing and wood sawing. It is interesting to note that one lady frequently milks 30 cows with electric milking machines without any other assistance. The largest motors are that at the saw mill,

developing 36 h.p., and that at the butter factory, developing 15 h.p. In general a 3 h.p. motor is ample for driving both milking machine and separator, but it is found that the farmers prefer a 5 h.p. motor because it can also be used for such purposes as cutting chaff, sawing firewood, grinding corn, and for other uses for

Table 1

Appliance	Number	Total Wattage Installed
Lights	182	10,023
Irons	19	10,925
Radiators	2	1,320
Stoves	3	12,600
Grills	3	1,860
Kettles	2	1,350
Motors	14	70,875

which a 3 h.p. motor would scarcely provide sufficient power. In three cases, a half horse power motor has been used for driving separators only, these being belted direct, the com-

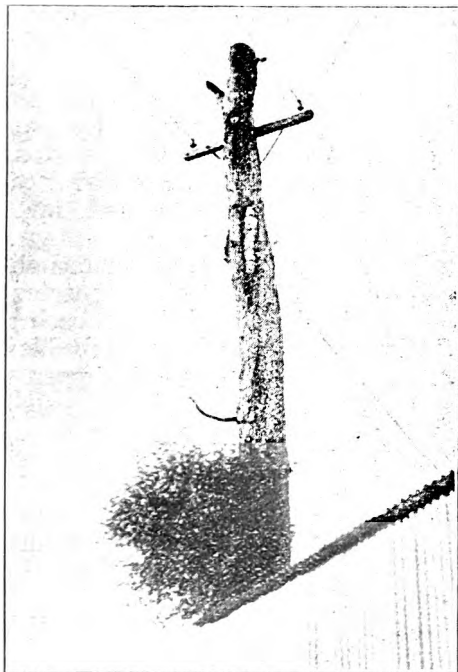


Fig. 4. An Economical L.T. Line Pole

bined unit being a very efficient little outfit. Farmers find it advantageous to install switches and plugs at various points about the farm, so that motors can be shifted and used at the point most convenient for the work in hand. A special type of protected plug, with an earth terminal, has been used for this purpose. Fig. 5 shows how a motor may be readily transported from place to place. For this kind of service, however, the motors at present on the market are not altogether suitable. The ideal farm motor should be almost totally enclosed, simple in design, light, and free from any starting equipment other than switch.

In addition to lighting and farm power installations, domestic appliances are now coming into use. The two-part tariff with fixed service charge, varying between 1/9 and 2/6 per month according to the size of house, and low energy charge, 1½d. per unit, encourages the use of power for domestic purposes. Since this tariff came into force, at the beginning of 1925, three stoves and a grillers have been installed. It is likely that six more stoves will be put in during the next few months. In connection with lighting there is one tennis court equipped for night play.

Cost Data

The cost of material for the low tension lines is calculable from the following schedule:—

Hardwood pole 30 ft. long, 12 in. dia. at 6 ft. from butt.	£1 13 0
Pole cap, 7 in. dia.	0 6 6
Pin insulators (4 per pole, at 1/-)	0 4 0
Insulator brackets (3 per pole, at 2/-) . .	0 6 0
Coach screws (15 per pole, at 1½d.) . .	0 1 11
Tar bitumen compound	0 0 4
Bare copper cable, 7/.083 (per 100 yd.) .	0 18 0
Bare copper cable, 7/.064 (per 100 yd.) .	1 14 6
Bare copper cable, 7/.044 (per 100 yd.) .	2 13 6

Price of pole is delivered at contractor's siding.
Prices of other materials are f.o.r., Melbourne.



Fig. 5. Transporting a 5 H.P. Motor around the Farm

Before erection the sapwood is removed from the pole from 1 ft. above the ground line to 2 ft. below, and the surface thus exposed is painted with two coats of hot bituminous compound. One gallon of the compound is sufficient for six poles. The insulators are placed to allow 1 ft. 6 in. spacing between the wires, and with a span of 250 ft. the maximum sag of the wires is 3 ft. 6 in.

Observations are being made with a view to arriving at the average cost of operation of various farm appliances with electric power. Energy for motors used in the farm service is retailed under a two-part tariff which makes a

service charge of 6/- per month where there is under 50 h.p. installed, while the actual energy consumed is charged at 1d. per unit. From careful checks, it has been found that a two or four stand milking machine will use 1,260 units of energy per year (210 days), and on the two-part tariff would cost 1/6 per operating day for energy. It should be noted that the consumption depends upon the size of plant unit used; i.e., it will cost less to milk 30 cows with a six stand plant than with a two stand. For

chaff cutting the energy consumption is about $2\frac{1}{2}$ units per ton. If a 20-ft. elevator be used as well, the consumption will be about $3\frac{1}{2}$ units per ton. For sawing hardwood the energy consumption is about a unit per ton.

For the month of June, 1925, the total energy purchased as bulk supply for the scheme was 3,654 kw. hr. and the maximum demand 15 kw. The load factor was 33.9 per cent, the diversity factor 13.8 per cent, and the connected load 109 kw.

Starting Characteristics of the Heemaf Type S.K.A. Induction Motor

Ordinary squirrel cage motors, when connected directly across the supply voltage to start, usually develop a maximum torque somewhere between the values of full load torque and twice full load torque, but require a starting current of six to eight times full load current. Owing to this large current consumption it is not advisable to connect large motors of this type directly on to the supply at starting. In most cases

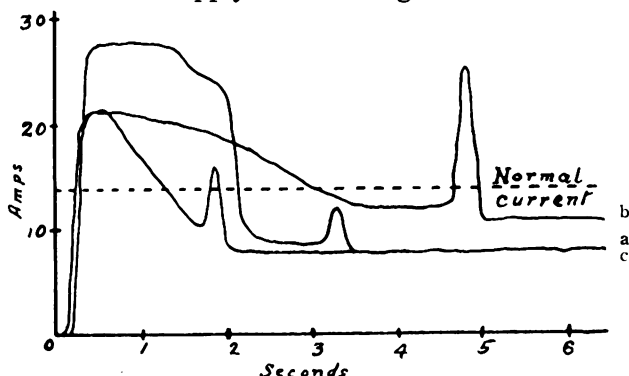


Fig. 1. Comparison of current consumption of ordinary squirrel cage motor at 33 percent load (a), with that of Heemaf type S.K.A. motor of same size at 71 percent load (b), and 33 percent load (c).

electricity supply authorities allow of motors up to about 3 b.h.p. capacity being started by direct connection, but above this size some such device as a star-delta switch or autotransformer starter must be used in order to limit the current rush. The application of a lower voltage than normal to the motor terminals, however, affects the starting torque, which is proportional to the square of the voltage applied. With a star-delta switch, therefore, the starting torque may be reduced to a value as low as one-third of the full load torque. For this reason squirrel cage motors can only be used for starting under light load.

But, although its starting characteristic is against it, the squirrel cage motor possesses a

great advantage in its simple and robust construction. Furthermore it is suitable for practically every condition of service, and therefore efforts have been made to improve its starting qualities while still adhering to the simple construction. The Heemaf Co., of Hengelo, Holland, has succeeded in its efforts in this direction, and has designed and patented a squirrel cage motor with high starting torque and low starting current.

The Heemaf type S.K.A. motor has an ordinary wound stator, but the rotor contains two independent squirrel cage windings, each consisting of a number of copper bars, embedded directly in the rotor iron and welded to copper end rings. The outer winding has a high resistance and low inductance, while the inner cage has low resistance and high inductance. The cooperation of the two windings results in a high starting torque and low starting current. This patented construction enables the Heemaf motor to attain the named features without sacrifice of efficiency, slip or power factor.

In Table I are given values of efficiency and power factor determined by tests on two motors of this type at varying loads.

Table II gives test figures for torque and starting current, expressed in percentages of full load torque and full load current respectively, for Heemaf type S.K.A. motors when started with a star-delta switch.

These figures show that the Heemaf motor in the star position develops starting torque equal to about 70 to 110 per cent full load torque with starting current of about 130 to 175 per cent full load current. With ordinary squirrel cage motors the figures are about 40 per cent full load torque and 230 per cent full load current. When connected directly across the line with stator phases in delta, the values of starting current and starting torque for the Heemaf motor will be approximately three times

as great as those tabulated. Since the starting torque of the ordinary squirrel cage motor is comparatively small, it will be necessary in many cases, on account of the starting conditions, to use a larger size motor than is actually required at normal speed, or even to

150 per cent full load current, but due to the high starting torque rapidly falls to below full load current. This at the same time indicates the quick acceleration of the motor, which results in the current rush when switching over from the star to the delta connection being of shorter

Table I.

	Load	1/4	1/2	3/4	Full	5/4	3/2
5 b.h.p. 220/380 volt four pole motor	Eff. % . . .	74.5	85.5	87.5	88	87.5	85.5
	P.F. . . .	0.4	0.69	0.805	0.85	8.855	0.85
40 b.h.p. six pole motor	Eff. % . . .	82.5	88	90	90	89.5	
	P.F. . . .	0.57	0.775	0.84	0.865	0.87	

use a more expensive motor of the slip-ring type. In such cases the Heemaf motor could be successfully applied.

The figures in the last column of Table II are derived from the ratio:

Starting torque in per cent of f.l.t.

Starting current in per cent of f.l.c.

This value is called the Specific torque, and in a way it expresses the amount of torque obtained with unity current. Since this value for ordinary squirrel cage motors amounts to .15 to .25 it will be seen that it is about 2.5 times larger for the Heemaf motors. In Fig. 1 the current consumption of an ordinary squirrel cage motor is compared with that of a Heemaf type S.K.A. motor of the same size when started with a star delta switch. From curve c it will be seen that the first current rush reaches about

Table II.

B.h.p.	R.p.m.	Starting current, % f.l.c.	Starting torque, % f.l.t.	Specific torque
5	1,500	150	100	0.67
10	1,500	145	95	0.655
12	1,500	175	110	0.63
15	1,500	155	105	0.67
20	1,500	170	110	0.65
25	750	130	70	0.54
40	1,000	150	80	0.535

duration than with the ordinary squirrel cage motor. The factory representatives of the Heemaf Co. for Australasia are Messrs. A. Beal Pritchett (Aust.) Ltd., and there are distributors for each state.

THE AUSTRALIAN COMMONWEALTH ENGINEERING STANDARDS ASSOCIATION

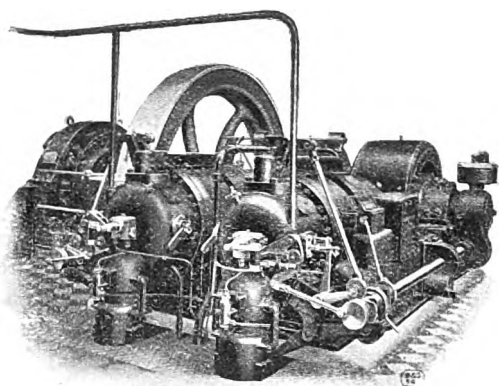
The Tentative Standard Specification for Railway Rails and Fishplates has been issued, also Tentative Standardisation of Methods of Sampling and Analysis of Plain Steels, Alloy Steels, and Pig Iron. These tentative standards are published for a period of twelve months for the purpose of eliciting criticism and suggestions, and are subject to revision until adopted as standards of the association. The first-mentioned deals with such matters as the chemical composition, workmanship, testing and inspection of rails and fishplates, and gives fully dimensioned drawings of the various sizes. The latter deals very fully with the sampling and analysis of the materials mentioned, so that chemists representing both parties to a contract may use the same methods when checking the chemical composition of material supplied to standard specifications. The methods are described in detail and the text is illustrated with diagrams of the apparatus used.

THE COMMONWEALTH ENGINEER

The November number of the "Commonwealth Engineer" contains two or three articles of interest to electrical engineers. There is a description of the boiler plant at the Yallourn power station of the Victorian electricity commission, illustrated by a fine general arrangement drawing of portion of the installation. The boilers were supplied and erected by Messrs. John Thompson Water Tube Boilers Ltd., Wolverhampton, England. There is also an interesting note on a new electrically-driven luffing crane, of local manufacture, recently erected on the wharf at Fremantle, W.A. Amongst articles of more general interest is an illustrated description of the Wimmera-Mallee domestic and stock water supply scheme in north-western Victoria. This scheme is the largest of its kind in the world, giving supplies over an area of about 11,000 sq. miles. Other articles deal with the Cave Hill limestone quarries at Lilydale, Vic., and with road-making both with cement and bituminous concrete.

New Blackstone Crude Oil Engine

Power users throughout Australia are well acquainted with the high reputation of the crude oil engines manufactured by Messrs. Blackstone and Co. Ltd., of Stamford, England. The firm has been manufacturing engines since 1837, and its crude oil engines have been on the market for nearly 20 years. Experiments were carried out by the company some years ago with the object of eliminating the troubles that were then occurring in the Diesel type of engine due to the high pressures employed. As a result an engine of low compression was evolved, using compressed air injection and hot bulb ignition. It is believed that the introduction of this engine first gave rise to the name Semi-Diesel. Large numbers of these engines have now been built



300 b.h.p. Blackstone Cold Starting Crude Oil Engine driving Electric Generator

and the results obtained, particularly in regard to simplicity, low running cost and perfect combustion of fuel, have been excellent.

To meet the demand for a cold starting engine the firm has now evolved a Spring Injection, cold starting crude oil engine which has been designed to work at moderate pressure on crude, residual, tar or shale oil without the use of compressed air for the injection of the fuel. Hitherto in cold starting crude oil engines very high compression and initial pressures have been the rule, the idea being to instantly vaporise and ignite the fuel on its entry into the combustion chamber. Experiments have proved that fuel injected at a much lower pressure so as to secure a prolonged combustion gives better results, one of which is a flat top diagram with an increased area and more perfect combustion of the fuel. The indicator diagrams of the spring controlled engine follow nearly along the lines of the old favored Blackstone crude oil engines which are the ideal, combining constant

pressure and constant volume. The guaranteed fuel consumption of the new engine is 0.4 lb. of standard fuel oil per b.h.p., and the mechanical efficiency at full load is around 85 per cent.

The fuel is injected by means of a spring plunger composed of two members with a spiral spring between. To one end of this plunger fuel is delivered by a governed pump. The fuel moves the whole of the plunger with its spring bodily outwards so that the pump does not have to work against pressure. The spring of the plunger is then compressed by a lever which presses upon its outer member, the inner one being held by abutting upon the fuel, which is retained by the spraying valve. At the inward end of its travel the lever relieves the pressure of a second or auxiliary spring (which normally keeps the fuel spraying valve closed against the injection pressure) allowing the pressure of the fuel to open the valve, when the spring of the plunger expands, forcing the fuel past the valve into the combustion chamber where it is ignited by the heat of the compressed air.

Spring injection has been proved to be a great advantage in starting as it enables the engine to be started up from cold with the fuel upon which it is to be run, no petroleum or other fuel being needed. Provided it is possible to pump the fuel without warming, it is not necessary that the fuel be preheated before entering the injector of the engine. Another advantage is that the fuel is injected under the same pressure and speed whether the engine be running at its normal speed or slow as at starting.

The engine has a compression pressure of approximately 380 lb., the initial pressure on full load being 550 lb., with a mean effective pressure of 100 lb. per sq. in. Each engine is fitted with a self starter which will allow it to be started up instantly on its own fuel. No supplementary air compressor is needed in order to charge the pressure containers, these being charged automatically from the engine cylinder whilst the engine is at work. A special patented device is fitted so that engines of 100 b.h.p. and below can be started by hand without compression. The Spring Injection crude oil engines are manufactured in powers ranging from eight to 600 b.h.p.

The municipal council of Wagga, N.S.W., has engaged Messrs. Lincolne, MacDougall and De-maine, consulting engineers, Melbourne, to advise on several points in connection with the proposed bulk supply of electrical energy to the town from the Burrinjuck hydroelectric scheme of the N.S.W. public works department.

Tramway Undertakings in Difficulties

Tramway undertakings throughout the Commonwealth are passing through a difficult period, brought about by considerable increases in operating costs and by the competition of motor bus services. As a consequence practically every undertaking shows a loss on its operations during the last year or two. In an endeavor to find some relief, the various authorities in four of the states have combined to take action, in arbitration proceedings, in serving a log of wages and conditions on the Australian Tramway Employees' Association. The association has filed a new log of wages, etc., as a counter claim. The employers represented are the Melbourne and metropolitan tramways board, the commissioners of the New South Wales railways and tramways, the Adelaide municipal tramways trust, the Hobart city council, the Launceston city council, the Melbourne Electric Supply Co. Ltd., and the Electric Supply Co. of Victoria Ltd.

The employers claim that the minimum rates of wages should be based on the basic wage, plus 6d. per hour for tram conductors, 1/- for drivers and 1/- for signalmen. This represents a reduction of from 1/- to 1/6 per day on old award rates. Regarding hours, the employers ask that the court fix twelve shifts a fortnight, of 96 hours. No special time for a working day is set out. The employers also claim that overtime and Sunday time should be paid for at the rate of time and a quarter over nine hours. On the recognised holidays, it is submitted that time should be paid for at the ordinary rates, provided that not less than twelve days' annual leave is allowed. If less than twelve days be allowed, holidays should be paid for at the rate of time and a half. A claim is made by the employers that as far as practical not more than one "call back" shall be made in any one week, and that where an employee is required to work on his day off he shall be paid at the rate of time and a quarter.

The employees' claims in the various sections and grades, vary from £6/10/- to £8/8/- per week. They ask also for a 44-hour week; that the period of duty shall not exceed seven hours twenty minutes daily on six days a week; when the day off is cancelled the employee should be paid double time, and should not receive less than a full day's pay, irrespective of the hours on duty; a minimum of 40 minutes and a maximum of 50 minutes for meals; no employee to work more than four hours without meal relief; the employer to give seven days' notice of intention to alter or cancel the day off; no employee to commence a day's duty until he has had at least twelve hours off duty; day and

night shift by rotation; double rates for Sunday pay up to seven hours and twenty minutes, thereafter half rate additional; 28 days' annual leave on full pay. The association also claims concessions in the way of free holiday passes for an employee, his wife and family, for all employees on state government tramways; four privilege passes for employee, wife and children during the year; a pass entitling him to travel free on the railways; one month's sick pay annually; that motormen or drivers' cabins should be completely closed in, and fitted with side doors and sun blinds; uniforms for drivers, conductors and outside employees to be provided.

The evidence given before the Commonwealth arbitration court by the representatives of the different undertakings shows clearly the unsatisfactory position to which the services have been brought. The Melbourne tramways board has a deficit of £232,245 on its operations for the last financial year. The board is subject to many financial restrictions and grants employees many privileges. During the past year signing-off time cost the board £37,546 per annum; the annual cost of making men's time up to 48 hours was £6,000; annual cost of penalty payments, such as call backs, stand-by time, overtime, including Sundays and holidays, £61,500; annual leave (for traffic men only), £31,653; cost of equipment, uniforms, etc., for twelve months, £22,335; contributions to benefit society, £4,373; sick pay, £5,234; retiring gratuities to old servants, £4,586. That the service is attractive is proved by the fact that, during the year, there were 7,000 applications for 395 vacancies on the staff. Under the present act and conditions the board's only means of recouping its losses is by increasing the fares or levying a municipal rate.

The N.S.W. railway commissioners, who operate tramway undertakings in Sydney, Newcastle and Broken Hill, seek to establish their right to exist as an asset to the state and not as a burden. During the last financial year the average earnings per mile of track were £15,857, as compared with £16,070 for the previous year, while the working expenses per mile of track were £13,910 and £13,671 respectively. The tram mileage has been increased, but the number of passengers carried has decreased.

In Adelaide the loss incurred by the municipal tramway trust on its operations up to the end of July last totals £72,513. Motor bus competition is keen, and the trust is running its own fleet of buses in an endeavor to meet this. During the last year the cost of making up the men's time to 48 hours a week was £9,136;

penalty payments, call backs, stand-by time, overtime, etc., cost £27,848; annual leave (traffic men only), £7,878; uniforms and equipment for twelve months, £3,172; contributions to Tramways Club and benefit funds, £1,320, making a total of £49,357, which was equivalent to 23.52 per cent of the wages paid to drivers and conductors. The service is very attractive and the trust never has to advertise for men.

In Hobart there is at present no competition from motor buses, but the tramways are only just paying their way. The position is bad because the renewals reserve fund has fallen very low, and the excess of revenue over operating expenses, interest, etc., is not sufficient to allow of adequate annual appropriations to the reserve being made. From an economic standpoint it is not possible to increase fares on the system, or to reduce the frequency of the services.

In Launceston the tramways are operating at a loss and a special rate is levied to make up the deficit. It is felt that it is unfair that many who do not use the trams should be compelled to help pay for their upkeep.

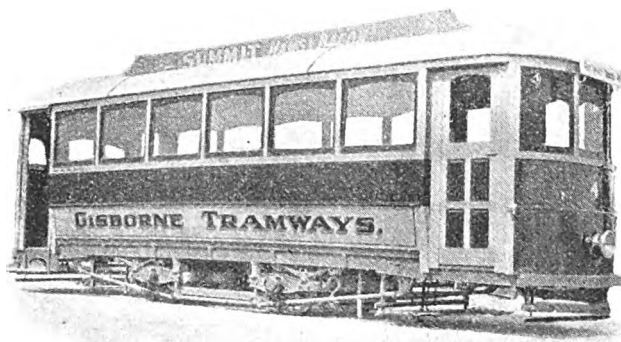
The Electric Supply Co. of Victoria Ltd. operates tramway undertakings in Ballarat and Bendigo. These undertakings are in such a position that the excess of revenue over operating costs for the last year has been all absorbed in depreciation, leaving nothing whatever for interest on capital. Motor bus competition is keen and although the tram mileage has been increased the revenue has fallen off during the last two years. In order to make ends meet the company has for many years operated certain of its routes with one-man cars, and where conductors were necessary juniors have been employed on the work.

The Melbourne Electric Supply Co. Ltd. operates the tramways at Geelong. On this undertaking a loss of £15,500 was incurred during the last year. The company is not allowed to charge more than a threepenny fare, and is compelled to conform to a certain time table. Regulations have been made in order to check motor bus competition, but it is alleged that they are not being put into adequate effect.

The case is still before the court, and arguments for the employees have yet to be heard.

Storage Battery Trams

The borough council of Gisborne, N.Z., provides transport service by the operation of a tramway system using storage battery cars. There are $3\frac{1}{2}$ miles of 4-ft. gauge track and four cars, two seating 26 passengers and two seating 30. Power is derived from Edison



Storage Battery Tramcar

batteries of 120 cells each and the drive is by two 10 h.p. motors on the smaller cars and two 18 h.p. motors on the larger. The cars are capable of speeds up to 23 m.p.h. on level track, and the power cost averages 2.38d. per car mile. The batteries are charged at night from the council's electric supply station, and a charge is sufficient for running 100 miles. Unfortunately

the undertaking has not proved a financial success. The latest balance sheet discloses a loss of over £5,000 on the operations during the past year, while the loss since the inception of the system some 12 years ago is no less than £13,354. Even at this no allowance is made for depreciation, nor is account taken of the amounts allocated to the tramways by means of rates and transfers of money from the electric supply department.

In view of the unsatisfactory financial position and the need for extension of transport facilities the council has had a report on the system prepared by Messrs. Vickerman and Lancaster, consulting engineers. This report recommends the extension of the present system, pointing out that the trams themselves are quite efficient, but that the losses have been brought about by non-technical causes. It transpires that the few miles of track laid since the scheme was inaugurated have not tapped all the sources of potential income from the residential suburbs, and that under the existing conditions no tramway system could have been operated successfully.

The consulting engineers have given consideration to several systems for improving the transport service, viz., extension of the present system, or installation of a new system, either trolley cars, trackless trams, petrol buses or battery buses. They point out that, although the capital

cost is lowest for petrol buses, the consideration of operating and maintenance expenses turns the scale in favor of the battery trams against all competition. Therefore they recommend the

overhauling of the present plant and extension of the system. For the present, however, the matter is in abeyance pending the placing of certain loan proposals before the ratepayers.

Melbourne Tramways

The Melbourne and metropolitan tramways board has issued its report for the year ended June 30, 1925. The outstanding feature of the operations is that the revenue has proved insufficient to make provision for the various appropriations required under the board's acts, after meeting working expenses. The deficit, which has had to be met by making an inroad on the general reserve fund, is £232,245. The total revenue amounted to £1,968,785, and the working expenses totalled £1,678,568, leaving a gross credit balance of £290,217. After payment of interest on loans and overdraft and on renewals and other reserves, payment of rates and of contributions to certain funds, there is a balance of £117,512 available for appropriation. The appropriations made are as follow:—Payment to consolidated revenue of the state, £106,211; to renewals reserve account, £117,269; to general reserve account, £80,731; to fire insurance reserve account, £4,000; to loan redemption and sinking fund accounts, £41,546. The majority of these payments are obligatory under various acts of parliament, and their net result is to produce a deficit of £232,245. This has been made up by transference from the general reserve fund, which fund in consequence is now seriously depleted, standing at only £22,930.

The board's indebtedness for loans at June 30, 1924, was £1,817,807. During the year under review sums totalling £1,700,000 were borrowed by the issue of inscribed stock. The total indebtedness at June 30, 1925, was £3,384,724. The board is empowered under its act to borrow up to £3,000,000. Its unexhausted borrowing power at June 30 was £850,000. Preliminary consent has been obtained from the government to borrow £650,000, and application is to be made for increased borrowing powers. Considerable sums of money are required for developmental work and for conversions of cable tramways to electric traction.

During the year the tram miles run on the cable and electric systems totalled 23,712,432, and the passengers carried totalled 228,752,100. Both these figures show an increase over those for the previous year, the principal reason being that four new lines have been put into operation. The total length of track laid during the period is 15.85 miles. A considerable amount of track reconstruction has been carried out, much of

which has been necessitated by the different local councils improving the road surface and requiring the tramway board to bring its permanent way up to the new standard. In some instances the track levels have had to be considerably altered. The new lines have a total route length of $6\frac{3}{4}$ miles, some double and some single track.

Considerable additions have been made to the rolling stock during the year. Delivery was taken of 120 class W bogie electric cars, and orders have been placed for a further 60. A great deal of the construction work is being done in the board's own shops. The stock of electric cars now totals 306, comprising 168 single truck and 138 bogie cars. No new cable rolling stock was constructed, and in this department the equipment now comprises 539 standard cars, 58 bogie cars and 590 dummies. On the cable system alterations to the power plant have been carried out in several of the engine houses in order to increase the rope speeds. There are 26 ropes on the various routes of the cable system, and 15 of these now run at speeds over 13 m.p.h. The average schedule speed of the cable cars is $9\frac{1}{2}$ m.p.h., as compared with 10 m.p.h. for the electric cars.

New building and plant installation work includes the completion of the paint shop and car body shop at the Preston car-building and repair works. An extension has been made to the Coburg car shed, and a new cable depot has been constructed for the North Melbourne line. A commencement has been made on the construction of a depot at South Melbourne, to house 72 bogie cars and provide necessary traffic offices. Plans are being prepared for a new head office to be located in Victoria street, Fitzroy. New substation buildings have been erected in Windsor and South Melbourne. Six substations have been put into service during the year, the equipment including seven 500 kw. rotary converters. Two of the stations have been equipped with one 500 kw. and one 300 kw. motor generator set respectively, which were transferred from another station. Contracts have been let for the supply of six 1,000 kw. converters for further substations.

During the year a fleet of 44 motor buses was put into service, partly to meet private bus competition and partly to provide transport during the conversion of certain cable lines to

electric traction. The board was not granted all the routes for which it applied to the government, the minister being of opinion that certain routes should be reserved for private owners. The buses have locally-built bodies on Tilling-Stevens, Thornycroft and Garford chasses, and the seating capacity varies from 20 to 33. During the period since commencing services the buses have covered 287,683 miles and carried 1,418,456 passengers. The total revenue earned was £20,519, and the working expenses amounted to £17,294.

The following tabulation gives general statistics of the operation of the three services under the board's control during the year under review.

	Cable	Electric	Bus
Mileage of double track	45.6	66.3	7.3
Mileage of single track	—	16.2	—
Tram miles	15,285,913	8,426,519	287,683
Passengers carried	148,316,398	80,435,680	1,418,456
	£	£	£
Total revenue	1,192,103	756,163	20,519
Working expenses	1,011,630	649,644	17,294
Percentage working expenses to total revenue	84.86	85.91	84.28
Average traffic receipts per tram mile	d.	d.	d.
	18.61	21.36	16.97
Average traffic receipts per passenger	1.92	2.24	3.44
Average working expenses per tram mile	15.88	18.50	14.43

The tramway board realises that its present financial position is unsatisfactory, but points out that this is largely due to the nature of the appropriations which it is obliged, under law, to set aside each year. Of these, that to the state consolidated revenue is used for purposes entirely unconnected with the tramways, being divided as contributions to the metropolitan fire brigades' board, the infectious diseases hospital and the publicans' licences equivalent. The government realises that such charges are unfair to the tramway system, but will make no alteration, stating that the municipalities should take over the liability and meet it by increased rates. Again, the board is arbitrarily required to set aside each year, to its general and renewals reserve, funds not less than four per cent nor more than six per cent of the capital cost of its undertaking, whether this amount is available or not. The expression capital cost includes assets of all descriptions, including freehold land. These funds are formed for the purpose of meeting the cost of converting the cable tramways to electric traction, expenditure upon renewals, or to cover deficits. Although the maintenance of such funds is necessary the board contends that the basis upon which the money is set aside is not equitable. Further expenditure devolves upon the board in respect of the construction and maintenance of the portion of any road occupied

by a tramway, the provision of street lighting where there are electric tramways, and in the public policy of requiring the board to defray a proportion of the cost of community improvements such as the erection of bridges, widening of streets, etc.

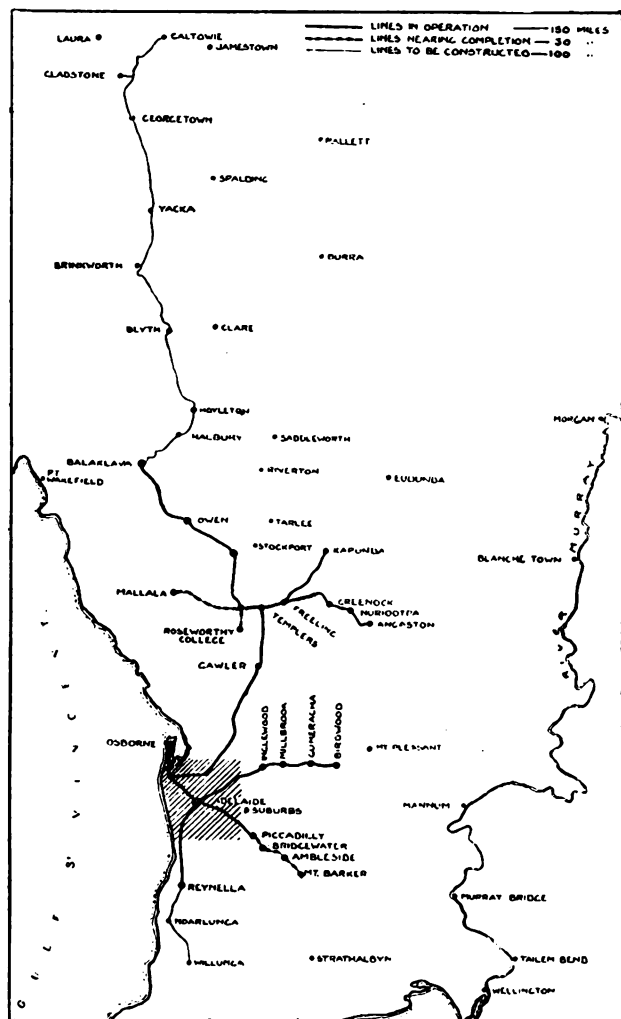
Apart from these various appropriations the board has been faced during the last few years with considerable increases in the wages of its employees, thus greatly inflating the working costs. At the same time the competition of privately owned motor buses has been a considerable check upon increase of revenue. To sum up, the position is that, although the board has been able to make ends meet this time by drawing upon its reserves, it cannot see its way clear to balance accounts next year. Under the act it is empowered to meet any deficit after the exhaustion of the general reserve, either by charging against the revenue of the following year or by the levy of a municipal rate. It also has the alternative of increasing fares. It is unlikely that the first course will be adopted, for there is no probability of future years being better able to meet liabilities than the present. The last course also, although a logical way of meeting increases in working costs, is likely to drive patronage to the competing bus services, and thus defeat its own end. The municipal rate proposal appears to be the best way out of the difficulty, for it has reason, in that it meets the deficit due to certain of the appropriations mentioned above by returning the charges to the place where they rightly belong. It may safely be assumed, however, that even the best of these alternatives will be unpopular, but if, while levying a rate, the board is giving good service and making every endeavor to meet its obligations by improving efficiency, it should be entitled to public sympathy and assistance.

VIRGINIAN RAILWAY ELECTRIFICATION

In the August number of the *Electrical Engineer* a brief description was given of the new electric locomotives to be put in service on the Virginian railway, U.S.A. Electric operation has now been commenced on this line. The service was inaugurated by moving a 6,050-ton coal train up the 2.11 per cent grade from Elmore to Clarke's Gap with two of the three-unit electric locomotives, one pulling and the other pushing. The grade was negotiated at a speed of 14 m.p.h., the whole trip taking just one hour. Under steam operation three Mallet locomotives took 2½ hours to haul a train over the section. With electric traction wired wireless is used for communication between the front and rear locomotives of a train, which are nearly a mile apart. The high-frequency carrier current is transmitted through the 11,000-volt trolley wire and the track.

Adelaide Electric Supply

The Adelaide Electric Supply Co. Ltd. is making a steady expansion of services, both in the city of Adelaide and in the surrounding country districts. The area of the districts covered by the company's statutory powers is approximately 2,706 sq. miles, with an estimated



Country Transmission Lines of Adelaide Electric Supply Co. Ltd.

population of 315,600. Electric supply is available in 772 miles of streets. The report of the company for the year ended Aug. 31, 1925, states that 51 miles of streets have been reticulated during the year, and the number of consumers has increased by 6,541. At the end of the year there were 60,243 consumers, an increase of 12 per cent over the previous year. Energy is supplied from a steam station of 30,000 kw. capacity at Osborne. The central portion of the city, which is supplied with d.c. energy, originally took its power from a steam station in

Grenfell street. This, however, is being closed down, and the load is now taken by a new converter station on East Terrace. The remainder of the area is supplied with alternating current, some single phase and some three phase. In order to cope with the increasing demand a new 10,000 kw. generating set, for delivery in 1927, has been ordered for the Osborne power station. With the closing down of the Grenfell street station, adjacent to which the administrative offices are situated, the company is moving into new offices on North Terrace.

The accompanying map gives an idea of the extent of the company's country district services, practically the whole of which have been put into operation during the last 12 months. The main transmission lines operate at 33,000 volts, and are nearly all constructed with Stobie steel-concrete poles. The secondary distribution is at 400/230 volts, 50 cycle three phase. Outdoor and pole type substations are used at all distributing centres.

The financial statement for the whole system during the last year shows that there was a 16 per cent increase in gross earnings over those for the previous year, while operating expenses plus taxes only increased by two per cent. The reason for the increase in expenditure being so slight is that considerable economies have been effected by the operation of the Osborne power station instead of the Grenfell street plant. The gross revenue for the year amounted to £616,353, and operating expenses and taxes totalled £309,265. After writing off the cost of recent share issues and providing for interest and sinking funds on debenture stocks there remained a balance on the net revenue account of £223,324. Out of this amount £65,000 was allocated to general reserve. From the balance interim dividends absorbed £76,518, and final dividends on preference shares £40,000, leaving £41,806. Further final dividends will absorb £40,882 of this, leaving £924. With the amount of £47,192 brought forward from last year there is now a total of £48,116 carried forward. The reserves of the company now stand at £447,915, out of which provision has to be made for depreciation and for writing off the Grenfell street power house. Owing to the satisfactory position, it has been possible to make certain reductions in the charges to consumers.

Comparative statistics of the operations for the last two years are as follow:—

	1924	1925
Number of consumers . . .	53,702	60,243
Lighting connections, kw. .	41,190	48,779
Motor connections, h.p. . .	26,701	31,336
Units sold	33,006,625	41,564,757

Adelaide Tramways

A steady expansion of services is reported by the Adelaide municipal tramways trust in the thirty-seventh half-yearly statement for the period ended July 31 last. Six new drop centre bogie cars were put into service and five more were in the contractor's hands. Nineteen Mack motor buses, with locally built bodies, were placed in service, and an order was given for 20 more, which are now in course of assembly. A shed to accommodate 20 buses was completed, and the provision of accommodation for the additional 20 is now in hand. The construction of the new tram track from Currie street, through the park lands and over the new Mile End bridge is nearly complete; the duplication of the Keswick route from West Terrace was completed shortly after the close of the period under review.

The financial statement of the trust shows that, in common with tramway properties in other places, the undertaking is passing through a difficult period. Operating costs are steadily on the up grade, due primarily to increases in wages, but the competition of other transport services is preventing the revenue from making a proportionate increase. The total revenue for the six months was £323,727, which, with a transfer from surplus reserve of £10,000, makes £333,727. The operating expenses, including items written off, amounted to £242,496. There was thus an amount of £91,231, available for appropriation. This was divided as follows:—Reserve for renewals, £16,952; interest on cost of construction, £59,755; to South Australian government in reduction by way of sinking fund, £14,000; balance carried down, £524. The actual amount due to the government was £45,580, thus there is a balance of £31,580 due on that account. There is also an amount of £4,229 due for interest on horse car purchase money, plus £133 interest. These items make the debit balance for the six months £35,418, which with £37,096 debit brought forward makes the total debit £72,514.

The actual loss on the operation of the Adelaide system was £29,191, and that on the Port Adelaide system £3,227. It must be noted, however, that the tramways are by no means in an unsatisfactory financial position as, after 13½ years' operation with electric traction, reserves totalling £985,733 have been built up out of revenue.

A certain amount of loss of revenue has occurred due to the removal of the surcharge on Sunday and holiday fares, the increase of the children's half-fare age limit from 12 to 14 years, and the granting of special concession fares on the Adelaide-Henley route. Making

allowance for the normal increase of traffic over the previous corresponding half, the loss works out at about £10,050. Nevertheless the various readjustments certainly brought about a considerable increase in passenger traffic, thus showing that they were of service to the public. The total number of passengers carried was 30,140,931, an increase of 1,208,265 over the corresponding half-year in 1924. The revenue, however, only showed an increase of £285, or 0.09 per cent over that for the corresponding period. The motor buses have been put into operation on three routes and, in addition, run to various suburbs on Sunday mornings. The bus mileage to the end of the period was 138,015, and the number of passengers carried 497,290. The buses showed a considerable loss, the ratio of operating expenses to revenue being about 149 per cent.

Particulars of operations of the Adelaide system, excluding Port Adelaide, for the whole year ended July 31, 1925, are given in the following tabulation:—

Number of cars in stock	231
Route mileage—	
Double track	48.4
Single track	17.1
Car miles run	6,860,256
Average speed, m.p.h.	9.48
Number of passengers carried	59,663,457
Population served	210,000
Passengers per car mile	8.7
Average journeys per head of population	284.1
Power consumption, units	17,713,107
Power units per car mile	2.58
Total revenue	£609,202
Revenue per car mile	21.312d.
Operating expenses	£443,081
Operating expenses per car mile	15.501d.
Percentage operating expenses to revenue	72.73
Motor Buses	
Total revenue	£6,216
Revenue per bus mile	10.808d.
Operating expenses	£9,256
Operating expenses per bus mile	16.095d.
Percentage operating expenses to revenue	148.915

CHRISTCHURCH TRAMWAYS

The report of the Christchurch, N.Z., tramways board for the year ended Mar. 31, 1925, discloses a deficiency on operations of £10,205. There was a decrease of 420,000 in the number of passengers carried, as compared with the previous year, with a consequent decrease in revenue from fares of £6,170. At the same time the operating expenses showed an increase of £9,641 and, owing to the raising of certain loans, the interest bill increased to £50,666. The percentage of interest to revenue is now 19.042. On the operation of the board's motor buses there is an excess of receipts over expenditure, the former standing at £3,481 and the latter at £3,210.

FREMANTLE TRAMWAYS AND ELECTRIC SUPPLY

The tramway system and the electric supply in Fremantle, W.A., are in the hands of a municipal tramways and lighting board. Energy is purchased in bulk from the government power station at East Perth. The report of the board for the year ended Aug. 31, 1925, shows the total income of the combined undertakings for the past twelve months to have been £122,088. The working expenses totalled £96,301, and loan interest less bank interest accounted for £8,051, leaving a balance of £17,736. Of this last amount £14,873 was appropriated to sinking fund, loan redemption and depreciation, and the balance, £2,863, contributed to the general revenue of the Fremantle and East Fremantle municipal councils. The total car mileage run during the year was 572,415, and the number of passengers carried 5,903,670. The total revenue per car mile was 22.861d. During the year three new bogie cars were put into service, bringing the total number of cars up to 28.

On the North Fremantle and Melville road board lines the car miles run were 50,574 and 35,985 respectively, and the passengers carried, 444,652 and 337,848 respectively. The traffic revenue for the former line was £4,414 and that for the latter £1,873.

In the electric supply undertaking there are now 4,458 consumers connected, an increase of 328 during the year. The revenue from the sale of electricity was £60,891. Mr. A. Mitchell is engineer and manager of the combined undertaking.

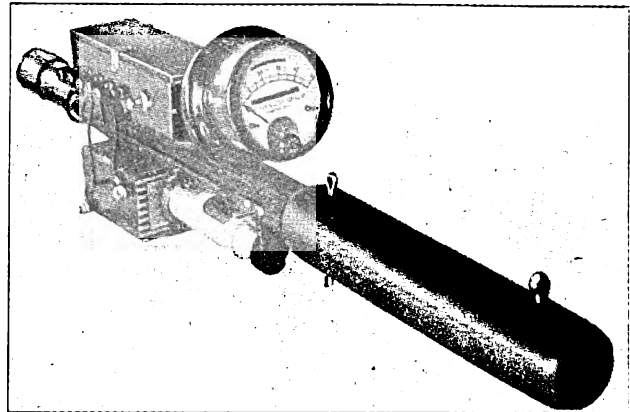
VICTORIAN HYDROELECTRIC SCHEME

The state electricity commission of Victoria has called tenders for turbo-generators, transformers, switchgear and cranes for the Sugarloaf-Rubicon hydroelectric undertaking. The scheme involves the laying down of six interconnected hydroelectric stations, all under supervisory control from a main switching station. The principal equipment required is as follows:—Sugarloaf station, 2-7,200 kv.a. turbo-alternators for net head varying between 60 and 113 ft. according to the state of the reservoir and the demands for irrigation, and seven 2,500 kv.a., 6,600/40,420 volt, single phase transformers; Snob's Creek station, one 4,150-kv.a. turbo-alternator for net head of 1,181 ft., and four 1,400-kv.a., 6,600/13,740 volt transformers; Lower Rubicon station, one 2,850-kv.a. turbo-alternator for net head of 269 ft., and four 1,000-kv.a., 6,600/13,740 volt transformers; Rubicon station, two 4,750-kv.a. turbo-alternators for net head of 1,381 ft., and seven 1,833-kv.a., 6,600/13,740 volt transformers; Royston station, one 800-kv.a. turbo-alternator for net head of

245 ft.; Rubicon "A" substation (the controlling centre), seven 3,000-kv.a., 22,000/40,420 volt transformers. The equipment for the Rubicon Falls station, consisting of one 350-kv.a. turbo-alternator, has already been ordered. The whole of the plant will run unattended, except for periodical inspection, being under remote supervisory control from Rubicon "A" substation. Energy will be supplied to Melbourne and to the north-eastern portions of the state.

THE ILER LIVE-LINE TEST STICK

Many operators of high tension lines have found a considerable increase in reliability to result from the systematic live-line testing of insulators made possible by the introduction of the buzz stick. A live-line test stick has now



Instrument Section of Iler Test Stick

been developed for which advantages are claimed over the buzz stick, in that results are more accurate, and quantitative comparisons are possible. By the use of this Iler stick an accurate record may be obtained of the potential gradient along an insulator string or a transformer or switch bushing. The accuracy of the instrument is obtained by the use of an indicating dial from which the comparative potential may be read, instead of depending upon an audible indication.

The device consists of a stick, with minimum length of 10 ft., carrying at its end a detachable metal contact connected by means of a wire with the indicating apparatus. The latter, which is shown in the illustration, is carried some distance down the stick. The instrument proper consists of a radio amplifier inductively coupled to the circuit by which the potential is brought down the stick from the insulator under test, and carrying an indicating voltmeter connected in the plate circuit. The wire which brings the potential down from the contact tip is encased in a micarta tube capable of withstanding a dielectric puncture test of 450,000 volts. The handle of the stick is of treated

wood and it is separated from the instrument carrying portion by an insulated section. A movable fibre disc is also provided for the protection of the operator. The whole apparatus, suitable for voltages from 2,000 to 132,000, weighs only 14 lb.

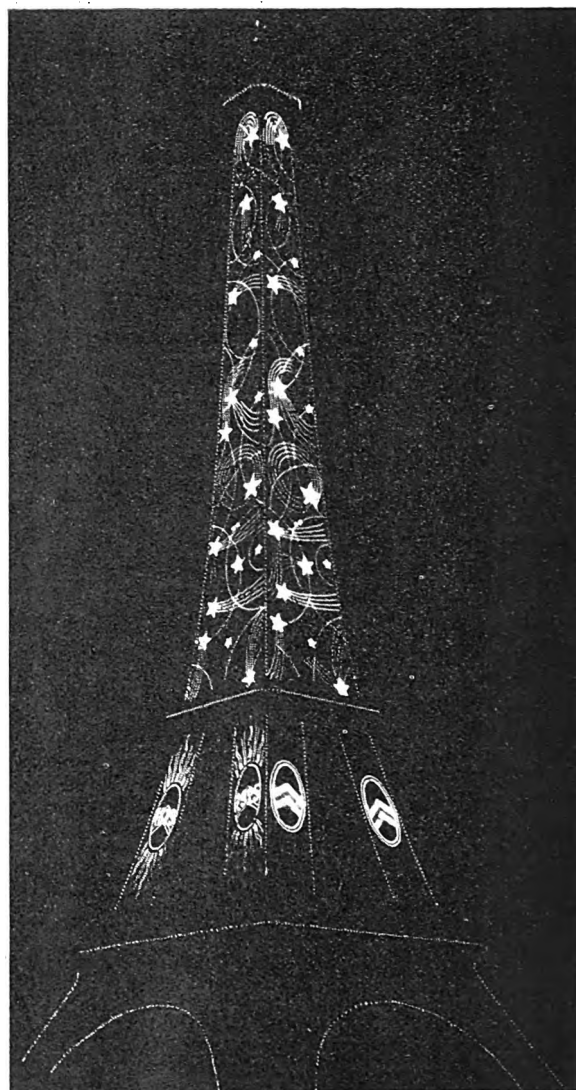
The device actually gives an indication of the potential to ground at any point along an insulator, and it is calibrated so that the voltage necessary to produce deflection varies with the voltage to ground according to the characteristics of the insulator. It is impossible to short-circuit an insulator with the contactor, as contact can only be made with one point at a time. In addition to its use for testing purposes, it is claimed that it can be used for direct measurement of line potential, and for the detection of surges.—“Electrical World.”

THE VENTURI FEED HEATER

For improvement of steam turbine efficiency by means of feed heating with steam bled from several stages of the turbine the Venturi feed heater has many advantages over other types of heater. With this apparatus neither separate pumps nor separate heaters are required. It consists of a tube of varying section, through which the feed water is passed. At the high-velocity sections the steam is introduced from the various tapped stages, to mingle with and heat the water. The water to be heated is raised to a pressure sufficiently higher than the boiler pressure to take care of frictional losses in the device. This may be done by standard feed-water pumps, preferably of the centrifugal type. In the apparatus the area of the feed water is gradually reduced and then gradually increased to that of the original pipe size, similarly to the reduction and increase of area in a Venturi meter. As in the Venturi meter, the operation of the device depends upon the law of hydraulics—that is, the sum of static head, pressure head and velocity head at any point in the pipe line is equal to the sum at any other point, disregarding losses. The section must be sufficiently reduced so that the pressure of the water is lower than the pressure of the lowest stage of the turbine from which steam is to be bled. The steam from this stage is introduced at this point and heats the feed water to the temperature corresponding to that pressure. At a point farther along the gradually increasing section, where the pressure, although higher than at the first point, is lower than the steam pressure of the next higher stage of the turbine from which steam is to be bled, this steam is introduced, raising the temperature of the water to the temperature corresponding to the higher pressures. In this manner steam may be taken from several stages without complication of apparatus.—“Electrical World.”

REMARKABLE ELECTRIC SIGN

The Eiffel tower, Paris, which is 984 ft. high, has recently been put to use to provide mounting for a remarkable electric sign. Some 600,000 Philips incandescent lamps have been arranged



Citroen Sign on Eiffel Tower, Paris

and connected to provide illumination which changes through ten successive phases and finally resolves itself into the word Citroen as shown in the illustration. The installation has been designed to combine attractive illumination with good advertising. At first the tower is outlined in luminous lines, then a number of stars and a comet appear while at the top of the tower bright flames shoot skyward. Further comets with lengthening tails then combine to form the word, while at the same time two signs appear on the lower part of the tower, bearing the dates 1889-1925, the former being the year

the tower was built. Almost immediately these signs change to form the Citroen trademark. The cycle of changes occupies 40 seconds. The current is supplied at 220 volts from a 1,000 kw. transformer station which takes supply at 12,000 volts. About 21 miles of main cable and 35 miles of insulated wire were used in the installation.

Radio News

At the annual meeting of the Sydney university radio club Messrs. K. W. Burrow and T. G. Phillips were elected honorary secretaries for the ensuing year.

A listener's league has been formed in Victoria, with the object of interesting the public in wireless and of effecting improvements in certain aspects of broadcasting.

The N.S.W. government intends to establish a state-controlled broadcasting station, which will operate in conjunction with six relaying stations, at an estimated cost of £10,000.

Mr. W. E. Coxon, of Perth, W.A., has been achieving considerable success with international communication. He has been in touch lately with a ship in the Phillipine islands, and with amateurs in Constantinople, Sweden and South Africa.

The official transmission station of the Wireless Institute of Australia, at the residence of Mr. H. A. Stowe, Royal street, Chatswood, N.S.W., was opened on Nov. 9. The station will be used purely for experimental work. The call signal is 2WI.

The trades and labor council of N.S.W. has opened a radio broadcasting station at the Trades Hall, Sydney, under the control of the president and secretary of the council. The power is 1,500 watts and the station operates on wave lengths of 280 or 35 metres.

At the last general meeting of the Association for Developing Wireless in Australia, New Zealand, and Fiji, a report aiming at the encouragement of C class wireless transmission was adopted. It suggested that persons living five miles from country towns, 25 miles from country cities, or 50 miles from capital cities throughout the Commonwealth should be allowed C class transmitting licences without examination and at a nominal fee, provided that their maximum transmitting wave length was 200 metres, and that their sets should not have a power greater than 25 watts input.

RADIO IN CENTRAL AUSTRALIA

Steps are being taken to provide radio communication facilities in the sparsely settled north central portion of Australia. Amalgamated Wireless (Aust.) Ltd. has erected a radio station for the Commonwealth government at Wave Hill in the Northern Territory, and a similar station is being erected at Camooweal, in Queensland. These stations will be capable of communicating with the coastal stations at Darwin, Thursday Island and Townsville. The call signals are VJD and VJJ respectively. In order to provide for the needs of settlers in outlying parts, Amalgamated Wireless has developed a 50-watt transmitting and receiving set that can be used for either telegraphy or telephony. The necessary power is derived from a crude oil engine driven generator. Sets of this nature installed at cattle stations remote from other means of communication will enable the owners to keep in touch with outside doings per medium of the government stations. The daily news bulletins transmitted from Darwin will be received at Wave Hill and Camooweal and relayed for the benefit of all who can listen.

BROADCASTING IN NEW ZEALAND

The Radio Broadcasting Co. of New Zealand Ltd., which was formed under arrangement with the post and telegraph department for the purpose of developing broadcasting in the Dominion, is pushing ahead with its plans for the installation of transmitting stations at Auckland, Christchurch, Dunedin and Wellington. Arrangements have been made for the purchase of the existing stations at the first three cities, but matters are not yet finalised in connection with the Wellington station. Orders have been placed with the Western Electric Co., England, for the supply of equipment of the most modern type for new stations to be built at Auckland and Christchurch. Each plant is designed for an aerial input of 500 watts. The equipment is expected to arrive in February, and construction will be put in hand immediately. When these stations are in operation the work of constructing the Dunedin and Wellington stations will be put in hand.

The geographical situation of these four principal cities of the Dominion is very favorable to broadcasting. When the first two stations only are in operation there will be no place in either island more than 350 miles from a broadcasting station. When the four stations come into operation there will be no place more than 230 miles from a station, and as a matter of fact by far the greater proportion of the area will be within 150 miles of a broadcasting centre.

AMALGAMATED WIRELESS

The report of Amalgamated Wireless (Australasia) Ltd., for the year ended June 30 last, shows that the company realised a net profit of £5,035. This is a considerable improvement over the previous year, when a loss of £21,856 was sustained. A very marked advance in business is shown, and the company appears to be in a sound position. The broadcasting sales department shows a satisfactory profit. Additional broadcasting stations, fabricated at the company's works, are in operation at Brisbane and Adelaide. Orders have been received for the supply of installations in the Northern Territory. The output of the works was considerably greater than in the previous year, and the valve works have greatly increased their production.

As required by the terms of the bill modifying the agreement entered into between the Commonwealth and the company in 1922, the directors have arranged for the erection in Australia of two duplex beam stations for direct service with Great Britain and with Canada. The necessary sites have been acquired, and the work on these stations is so well forward that their completion is anticipated early next year.

RADIO BROADCAST BUREAU

The radio section of the Electrical Employers' Association of N.S.W. is doing fine work in popularising radio to the benefit of both the industry and the public. In its publicity campaign it has the willing cooperation of the metropolitan and country newspapers and of the broadcasting companies. Items of interest sent to the newspapers are published in the sections where they are most likely to excite interest, e.g., a paragraph stating that 2FC was giving turf talks before important race meetings was included in the sporting news, and an announcement that a famous French coiffeur would talk on bobbing and shingling was inserted in the ladies' column. Such news items as these undoubtedly excite an interest in radio in the minds of people of different classes, and lead to the sale of receiving apparatus. To date the published matter in the press, including pictures, emanating from the bureau totals 4,904 in.

Another activity of the bureau is in making suggestions to the broadcasting companies in respect to the matter transmitted. For instance, on the nights preceding pigeon races 2BL was induced to transmit special weather forecasts covering the districts over which the birds would fly. A further activity has been in securing the cooperation of members of parliament in the work of popularising radio. Two dozen members of the state parliament have shown themselves sufficiently interested to write to the

Parents' and Citizens' Associations in their electorates, suggesting the installation of radio receiving sets in the schools. Such a task is no small job, one member, for instance, having to dispatch 147 personally signed letters.

The president of the bureau, Mr. R. Burgin, is the leading spirit in the campaign. He believes in leaving no field unworked. Radio must be linked up with every class. Its advantages to the man on the land, the woman in the home, children, invalids, and persons in the lonely out-back places must be continually kept before the public. All this work needs money, and the bureau appeals to the trade for more funds to keep the publicity going. In addition it asks for ideas and news incidents connected with radio which will help in driving the message home.

AUSTRALIAN BEAM STATIONS

Constructional work on the beam radio stations for two-way communication with England and Canada respectively, is proceeding steadily, and there is every probability that the contractors, the Marconi Co., will have the work completed

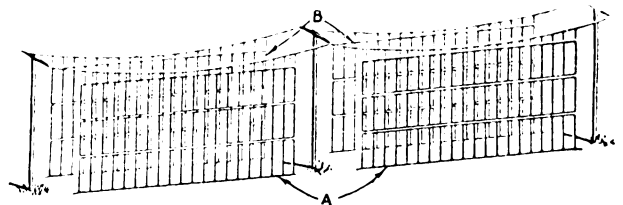


Fig. 1. Beam System Directional Transmitting Aerial

on schedule time, i.e., by January, 1926. The two transmitting stations are being erected about six miles south of the town of Ballan. 50 miles north-west of Melbourne, on a site comprising an area of about 450 acres, 1,450 ft. above sea level. The receiving stations are at Rockbank, about 15 miles north-west of Melbourne, on a site of 450 acres with about 1,500 acres in reserve, about 400 ft. above sea level. Both sites are in flat open country, and the distance of 25 miles between them is sufficient to allow of duplex working without interference. The areas are sufficiently large to permit of expansion by the erection of stations for communication with other parts of the world.

The beam system is in reality a short wave system in which the efficiency of transmission and reception is increased by the use of reflectors in conjunction with the antennae. In the case of transmission, the reflector concentrates the radiated waves in a definite path, thus giving a greatly increased intensity of wave front over that which occurs with broadcast radiation. At the receiving end the reflector acts as a collector of the ethereal waves, tending to throw them on to the receiving aerial and thus increase the signal strength. The net

result of the use of the reflectors is considerable economy in the power required both for transmission and for amplification. The aeriels and reflectors are placed in a direction at right angles to the path of the incoming or outgoing signals. In the case of the stations for communication with England, provision is being made for transmission and reception in two directions along the great circle—either north-west, a distance of 9,380 miles, or south-east, a distance of 12,219 miles. The stations for working with Canada will function in one direction only.

The aerial system at each station is supported on three masts and is of the form shown in Fig. 1. Each mast is of steel lattice construction, and is 250 ft. high and weighs 50 tons. At the head is a cross arm 90 ft. long. The masts are erected 650 ft. apart and they are stayed in four directions to anchors bedded in concrete. The aerial and reflector for each station consists of two separate systems of insulated vertical wires supported from other wires known as Triatics, which are stretched between the horizontal cross arms of adjacent masts. The height of each aerial and reflector is 200 ft., and each contains 50 vertical wires. The aerial and reflector are parallel in direction and identical in construction. The wires are of silicon bronze which combines high tensile strength with good conductivity.

The transmitter comprises a bank of rectifying valves, with first and second stage magnifiers and an independent drive unit. Each aerial system is energised from the transmitter by a distributory feeder system with suitable coupling arrangements ensuring correct phasing of the current in each aerial wire. Each of the 50 wires in the aerial and in the reflector is separately energised. The magnifiers consist of a number of oscillatory valves coupled to high frequency circuits tuned to the transmitting wave length. These circuits are arranged to cover a band of wave lengths up to 100 metres. The independent drive circuit consists of a separate low-power valve oscillator of the desired frequency, separately exciting the common grid circuit of the intermediate bank of oscillation valves. The filament heating of the magnifier and drive is obtained from a battery. The heating of the rectifiers is effected by a.c. energy transformed to the correct voltage, and regulated by means of chokes. Power for the two transmitting stations will be supplied by generators driven by three 150 h.p. crude oil engines, one of which alone is sufficient to carry the load.

The actual transmission and reception will be effected from a central office situated in Melbourne. Connection between this office and the stations is by land telegraph line. The lines run to a control table at the station, where the relays for operating the signalling switches are located. The signalling switches are placed close

to the oscillatory circuit of the independent drive, and are electro-magnetically operated. The control table also carries filament voltage rheostats and other controls which permit of adjustment of the transmitter at a distance from the oscillatory circuits. It is estimated that the operating speed each way will reach 100 words a minute. Messages from or to other states of the Commonwealth will be relayed by means of feeder stations located near the respective capital cities.

The following schedule shows the great advantage of the beam system for long distance communication, over the high-power transmission that was the only method until the development of short wave working. The estimated costs are for two receiving and two transmitting stations, providing two-way communication with England and Canada. The other figures apply to one station only.

Item	High-power	Beam
Cost	£487,000	£119,000
Masts: No.	20	3
" Height, ft.	800	250
" Distance apart, ft.	1,600	650
Aerial, Height, ft.	750	200
" Length, ft.	34,300	1,300
Power, kw.	750	35
Wave length, metres	24,000	30-40
Speed, words per min.	20	100
Guaranteed capacity, words per annum	8,640,000	51,840,000

PROPOSED INSTITUTE OF RADIO ENGINEERS

Steps are being taken in Great Britain to form an institution of radio engineers, the objects being to place the professional man in line with his equivalent in the Institution of Electrical Engineers, and to provide him with a journal consisting of 100 per cent radio matter. Members will require to have been professionally engaged for at least three years and must hold a position of responsibility at the time of application. They must also pass the necessary examination for such grade, the council having power to waive this in exceptional circumstances. Associate members must pass the examination laid down for this grade, and hold a position of responsibility at the time of application. Others not professionally engaged but possessing undoubted qualifications may be considered by the council. Associates will be admitted, subject to their being interested in the science of wireless and allied subjects, and their applications will receive the special consideration of the council. The provisional fees range between £5/5/- and £4 for home members, and between £4/4/- and £3 for members abroad. The honorary secretary of the temporary organisation is Mr. Y. W. P. Evans, 66 Oxford road, Manchester, Eng.

New Publication

Electrical Engineers' Data Books.—Edited by E. B. Wedmore, M.I.E.E. Ernest Benn Ltd., London. Three vols., pp. 519, 276 and 258 respectively. Illustrated and with extensive appendices. Price in Australia, 18/6 each.

For some time the necessity has been felt for a British electrical engineers' handbook comparable with some of the fine American specialists' handbooks. It is pleasing to note that this need has now been supplied by the production of this series of data books, each of which constitutes a very valuable reference work in its special field. The volumes are packed with up-to-date information on British electrical engineering practice, covering a remarkably wide range in comparatively small space. Vol. 1 treats of lighting, traction and power distribution. The illumination section covers everything necessary to the designing of an efficient interior lighting system. A section on batteries deals with the construction, installation, and maintenance of batteries, the greater portion of the space being devoted to lead accumulators. Under power distribution is a short section on power plant practice, and more extensive sections dealing with the design, installation and operation of underground and overhead transmission and distribution lines. The switchgear section deals with switches and circuit breakers, giving much useful design data, and devotes a considerable amount of space to the consideration of protective systems. Under electric traction is included a great deal of useful information on electric railway practice. There is also a section on motor control, and one covering the testing and maintenance of electrical machinery. All these various sections are interspersed with valuable charts and much tabulated data. The appendices to this volume cover 195 pages. Appendix A contains mathematical and miscellaneous tables, including trigonometrical ratios, hyperbolic functions, differential coefficients, and a list of integrals. It covers also a wide range of electrical, mechanical and physical tables, including properties of steam, tables of copper conductors, properties of electrolytes, etc. A further section is devoted to consideration of electrical and magnetic theory. Appendix B contains the various British rules and regulations governing the use of electricity.

Vol. 2 of the series deals with electrical manufacture, design and laboratory work. The principal portion is devoted to the important subject, Insulation, covering a wide range in the properties and testing of various insulating materials. The next section deals with electrical phenomena such as sparking over in air and in oil, and high voltage phenomena. Another important section deals with the properties of

metals as related to their electrical and magnetic requirements. Further sections deal with bridge measurements of electrical quantities and with pyrometers. The appendices are the same as those in vol. 1.

Vol. 3 deals with radio engineering and has special sections on telegraphy and telephony. The information is presented in concise form with due reference to the practical value of the various points. The sections cover radio calculations and measurements, tuning and radiation, thermionic valves, transmitters, receiving apparatus, design of masts and aerials, and miscellaneous information. The telegraphy and telephony section is descriptive of modern practice in these branches. The appendices are the same as those of the other volumes.

These three books should prove very valuable in their special spheres. Vol. 1 will be of assistance to the practical designing, manufacturing or operating electrical engineer, vol. 2 is suited to the needs of those dealing with certain aspects of design, research and testing work, and vol. 3 is full of most useful information for the radio technician. The value of the volumes appears to be out of all proportion to their price, and they will undoubtedly make a strong appeal to electrical engineers.

Trade Notes

Australian Electric Constructions Ltd. has been formed for the purpose of trading as electricians, engineers, etc. The authorised capital is £2,000, and the first subscribers are: O. T. Emery, G. F. Williams, Vera Worthington, Lorna Jobson, O. T. R. Emery, R. Mitchell and R. Bailey. The registered office is in Sydney.

The Micropump.—Messrs. McPhersons Pty. Ltd., Melbourne, are handling a small pumping outfit of French manufacture, known as the Micropump, which should have many useful applications. The machine consists of a centrifugal pump, with capacity of 500 gal. per hour against a head of 75 ft., direct driven by a universal electric motor rated at about 1 h.p. The outfit is mounted on a rigid bedplate and its overall dimensions are 14 in. long by 6½ in. wide. The normal energy consumption is about 500 watts. The pump has a bronze impeller and a bronze casing made in two parts. It is provided with screwed junctions and adaptors suitable for the attachment of either piping or flexible hose. The outfit is usually supplied with an automatic float switch control, so that it may be used for such services as keeping a tank filled to a predetermined level. The manufacturer guarantees the whole apparatus for six months.

New Trolley Frog.—The Westinghouse Electric and Manufacturing Co., U.S.A., is manufacturing a trolley frog of new design which, it is claimed, eliminates trolley wheel jumping at tramway intersections. The particular features of the device are overlapping runners, flexible connections, and the fact that the flanges of the trolley wheel do not touch the pan of the frog. In addition, the angle is kept small so that there is almost perfect transition from tangent to curve. The frog is sturdily built and attaches easily to the trolley wire.

Kay Transmission Towers.—Messrs. Noyes Bros. (Melb.) Pty. Ltd. have been awarded a contract by the hydroelectric department of Tasmania for the supply and erection of towers on the first section of the new three phase 88,000 volt Waddamana-Railton transmission line. The towers are of Messrs. Callender's Kay type, constructed of solid drawn steel tubes, and they will support three 7/.097 in. hard drawn copper conductors with minimum clearance to ground of 17 ft. The contract covers a 30-mile section of line, for which about 200 towers will be required. The full line will be 59 miles in length, but the contract for the second section has not yet been placed.

Rotaries for Sydney Railway Electrification.—The Metropolitan-Vickers Electrical Co. is supplying two 4,500 kw. rotary converters for installation in the Prince Alfred substation in connection with the electrification of the Sydney suburban railways. The machines are to run in parallel, supplying direct current at 1,500 volts. They are capable of taking a 25 per cent overload for two hours and of sustaining a momentary overload up to 10,000 kw. each. They are 16 pole machines, running at $187\frac{1}{2}$ r.p.m. The starting gear is semi-automatic in operation, the substation attendant merely having to push a button which starts an automatic train of operations to bring the machines up to synchronism. A further push button control then closes the d.c. circuit breaker, putting the machine on load. The same firm is also supplying two 1,500 kw., 750 volt converters designed to operate in series on the d.c. side, thus supplying 1,500 volt energy. These machines run at 500 r.p.m. and, like the larger ones, are under semi-automatic control. They will be installed at Hurstville.

Instantaneous Water Heater.—Amongst the many advantages of electricity in the home the greatest are the ease with which it may be controlled and the cleanliness of its application. These points are particularly evident where electricity is used for water heating, for it is possible by its agency to have always a supply of hot water on hand without the necessity of giving attention to the heater. There are now heaters of many different makes and types on

the market, each claiming certain advantages in efficiency or flexibility of service. In general they may be divided into two classes, viz., instantaneous heaters, and storage systems. The former are designed for providing hot water in quick time, and include in their class such apparatus as kettles, urns, and immersion heaters. The latter usually have a rather slow heater combined with some form of circulating system and thermostatic control.

For the Modern heater, which has recently been placed on the market, claims are made that it combines the advantages of both the above classes. It is an instantaneous heater in that it supplies boiling water within 30 seconds of



Modern Water Heater

switching on the current, while at the same time it has provision for storage and will continue to supply boiling or hot water indefinitely, in quantities within its capacity. The No. 4 size gives 30 pints boiling or 60 pints hot water per hour, and the No. 8 size gives double these quantities. If desired, the apparatus may be coupled up with a storage tank and equipped with thermostatic control to keep the water at a predetermined temperature.

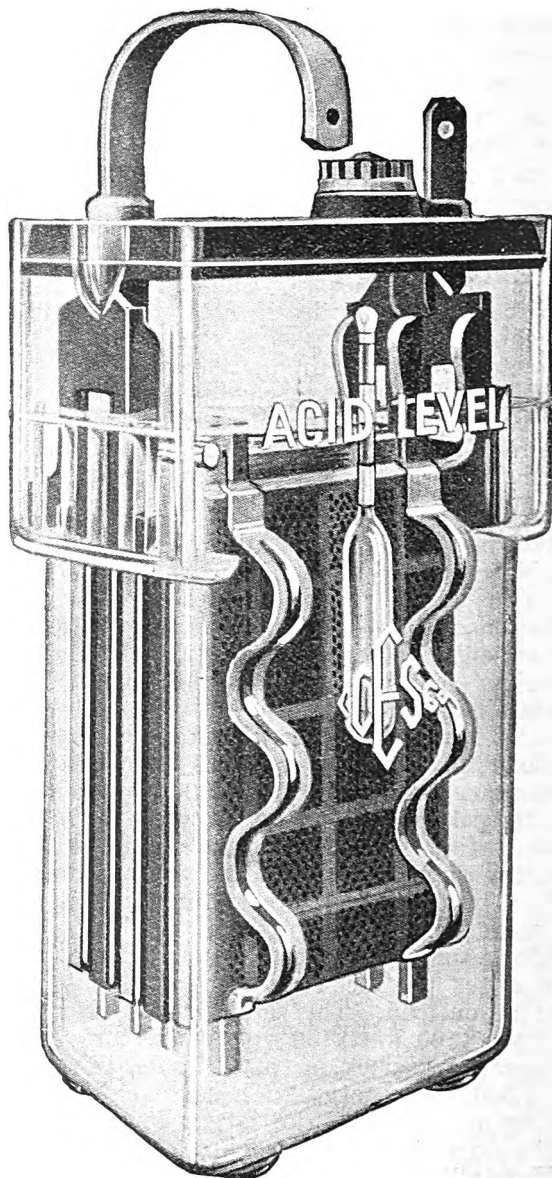
The heating element for the larger size is rated at 3 kw. It is wire wound, sheathed and completely immersed, and arranged to give a large heating surface. The instantaneous heating effect is obtained from the arrangements for water circulation which allow the water near

the draw off cock to become heated before the main mass. The supply of water to the heater is automatically controlled by means of a float operated ball valve, so that there is no danger of the container running dry. The price of the No. 4 heater is £7/15/6. Further information is obtainable from the manufacturers, Modern Electrical Appliance Co., 385 Little Lonsdale street, Melbourne.

Storage Battery Mining Locomotive.—The Metropolitan-Vickers Electrical Co. has recently produced a storage battery locomotive for operation underground in mines. Owing to the arduous conditions of underground service, particularly where inflammable gases are likely to be met with, the design of the machine embodies several special features. The specification to which it was built laid down certain fixed dimensions which could not in any circumstances be exceeded. One of the conditions was that the locomotive must be capable of turning through an angle of 90 deg. on a radius of 13 ft. with an overhang of not more than 12 in. In addition to the limitations on the mechanical side it was, of course, essential that all the electrical gear be made flame-proof, so that there would be no risk of explosion. The locomotive is of the four wheel type, with each axle driven by a spring-suspended motor through double reduction chains. The motors are flame-tight, and the high speed chains are totally enclosed. Brakes with shoes lined with Ferodo to eliminate sparking, are provided on each wheel, the operation being either by hand or by foot. The battery is of the Exide-Ironclad type, consisting of 35 cells, with capacity of 323 amp hours at the five hour rate. It is enclosed in a flame-tight box, of construction strong enough to withstand either an internal explosion or the external pressure due to a fall of roof. The whole battery, in its compartment, can be removed from the locomotive. The controller is of the cam-operated contactor type with a blow-out coil on each contactor. It is actuated by a dead man handle, and is totally enclosed in a flame-proof compartment. The locomotive is sturdily built, and its performances on trial indicate that it is well able to stand up to the exacting conditions of underground service.

New Features in Storage Battery Design.—The Chloride Electrical Storage Co. Ltd. has just put on the market a new and improved type of storage battery in capacities from 50 to 180 amp hours. The purpose of the design has been to secure simplicity of erection and of putting into service, and facilitate the renewal of parts, besides lengthening the useful life of the cell and eliminating sources of trouble. Simplicity of erection is obtained by: (1) Casting feet on the glass box, thereby dispensing with separate

insulators. (2) Distinctive, positive and negative connector lugs, thus making it practically impossible to connect up with wrong polarity. (3) The shape of the box being such as to facilitate easy carrying and erection in place on the stand. Simplicity of putting into service is secured by the design being most carefully worked out so as to reduce work involved in



New Chloride Storage Battery

assembling the cells to a minimum. The cell is designed to enable separators to be inserted and withdrawn without in any way disturbing the positive and negative groups. This feature is one not previously obtainable in any cell suitable for sealing in. Platforms are provided at the sides of the glass box, from which all the plates are suspended by lugs cast on, and glass partitions are cast in the box which definitely

separate plates of opposite polarity, these partitions being high enough to do away with any risk of short circuiting by the deposit of sludge. Provision is also made in the moulding of the box for sealing the cover. The moulded lid is provided with a hole for the admission of a special hydrometer, one being supplied with each battery. The aperture is closed with a vent plug. Further particulars may be obtained from the Australian representative of the company, Mr. E. H. Sharpe, 15 Castlereagh street, Sydney.

POSITIONS VACANT

The shire of Dunmunkle, Vic., invites applications closing on November 21 for the position of engineer in charge and collector to the Minyip electric light scheme.

An engineering assistant on the coal supply branch, Yallourn, is required by the Victorian state electricity commission at a salary of £450 per annum. Applications close on November 23. Experience in supervision and inspection of engineering construction and the investigation and checking of designs of structural and mechanical work is essential.

The Queensland state public service commissioner invites applications for the position of teacher of engineering subjects, Central Technical College, Brisbane, at a salary of £320 to £425 per annum. Subjects to be taught include engineering drawing, engineering mathematics, applied mechanics and heat engines. Applications close on December 8.

Lighting and Power

Ararat, Vic.—The operations of the municipal electric supply undertaking for the last financial year have resulted in a profit of £600. The finances of the undertaking have shown steady improvement since 1921, when a loss of £2,000 was sustained.

Auckland, N.Z.—The Waitemata power board has come to an agreement with the Takapuna Tramway and Ferry Co. whereby poles will be erected along the tramway route and used by both the board and the company. The board is opening a showroom in the city for the supply of electrical goods to its consumers.

Balclutha, N.Z.—Reticulation for electric supply is in progress, and a transmission line is in course of erection between Milton and Balclutha.

Balranald, N.S.W.—The shire council is raising a loan of £4,400 for an electric supply undertaking and has called tenders for the plant. Two crude oil sets, of approximately 50 and 16 h.p. respectively, will be installed. Mr. A. C. Bertoli, of Charlton, Victoria, is consulting engineer.

Benalla, Vic.—The shire council's electric supply undertaking shows a profit of £1,000 on its operations during the last twelve months, and the council, therefore, has decided on a reduction of energy charges from 1/- per unit for lighting and 6d. per unit for power to 9d. and 4d. respectively. The new rates will operate as from October 1. At the end of March, 1926, the electricity commission is to take over the undertaking, and this body has given a guarantee that the cost of energy to consumers will not exceed an average of 9d. per unit, with no charge for meters. When the undertaking is taken over the commission will avail itself of the services of the present engineer, Mr. H. Runge.

Berry, N.S.W.—A poll of ratepayers on the question of installing an electric supply undertaking at a cost of £7,000 resulted in an affirmative majority of 24. In all 124 voted.

Blacktown, N.S.W.—The proposed charges in connection with the shire electricity undertaking are as follow:—Lighting, 7d. per unit; domestic power, 4d.; industrial power, 2d.; plus £8/4/6 per kv.a. of maximum demand; meter rent, 12/- per meter per annum.

Braybrook, Vic.—The electricity commission has informed the shire council that it cannot supply electricity in the district as the area is already served by H. V. McKay Pty. Ltd., and the Footscray city council.

Bridgewater, Vic.—A proposal is on foot to utilise the Loddon river for a joint water supply and hydroelectric undertaking. The Marong shire council is to obtain information with regard to the scheme from the electricity commission.

Broome, W.A.—The road board is applying to the government for a loan of £10,000 for electric supply purposes.

Geraldton, W.A.—Following on consideration of a report from Mr. C. E. Crocker, general manager of the Perth electricity and gas department, the municipal council has decided to seek authority to raise a loan of £16,000 for the purpose of installing two additional 110 kw. crude oil generating sets at the electric supply plant, and of making extensions at the gasworks.

Gisborne, N.Z.—The borough council proposes to install an a.c. generating set to increase the capacity of the electric supply plant. The present d.c. distribution system will be retained in the central portions of the supply area, but the outer parts will be changed over to a.c.

Hamilton, N.Z.—Connections to the reticulation system of the Central power board now total 3,607, including 557 milking motors, 312 water heaters and 36 ranges.

Home Hill, Q'ld.—During the year ended June 30, 1925, the output of the electric supply plant, which is operated by the irrigation and water supply commission, was 960,343 units, of which 764,735 were for irrigation, and 19,096 for town lighting. The revenue for the year totalled £20,504, and the working expenses amounted to £8,014. The present plant includes a 1,500 kw. turbo-alternator, but it is considered that in order to ensure continuity of service a duplicate set will have to be installed.

Ithaca, Q'ld.—Electric supply has been switched on in the Herston district of the town. The undertaking is in the hands of the Greater Brisbane council. Energy is purchased in bulk from the City Electric Light Co., and distributed at 415/240 volts 50 cycle three phase.

Jamestown, S.A.—At a poll of ratepayers, it has been decided to sell the municipal electric supply undertaking to the Adelaide Electric Supply Co. Ltd., for £3,500. The undertaking has been showing a considerable deficit on operations, and an expenditure of about £3,000 for enlargement and reconstruction is necessary.

June, N.S.W.—The municipal council is dissatisfied with the proposal of the public works department to charge 1½d. per unit for bulk supply of energy from

the Burrinjuck hydroelectric scheme. The larger town of Wagga is to be charged 1d. per unit.

Kapunda, S.A.—Electric supply from the mains of the Adelaide Electric Supply Co. has been switched on. The energy is supplied over a transmission line from the company's power station at Osborne. The distribution system is 400/230 volts 50 cycle three phase a.c. About 40 street lamps, of capacities from 50 to 100 c.p., have been installed.

Launceston, Tas.—A further stage in the change over of the electric supply from 190/110 volts to 415/240 volts, 50 cycle three phase, has been completed, the districts of East and South Launceston having been changed over. It is estimated that it will take two more years to complete the work for the whole of the city.

Lorne, Vic.—Tenders have been received by the Winchelsea shire council for the supply, delivery and erection of a 50 h.p. crude oil engine driving a 45 kw. d.c. generator, for the electric supply undertaking.

Mildura, Vic.—The town council has received a large number of applications from consumers desirous of changing over on to the new one-meter tariff. During the last year of operation the electric supply undertaking realised a profit of £1,100.

Mt. Gambier, S.A.—When the municipal council embarked on its electric supply undertaking it was estimated that the capital cost would be covered by a £16,000 loan, that about 200 consumers could be expected at the end of the first year, and that the operations for the first twelve months would result in a loss of about £1,100. But the balance sheet for the first year, which has just been presented, discloses that the capital cost was £16,550, there are now 600 consumers connected, and a profit of £836 has been realised. The increased capital cost was brought about by the necessity for extensions consequent upon the great demand for energy. The plant is suction gas driven, and the distribution is at 460/230 volts d.c. Mr. C. M. Helmore is the electrical engineer.

Mulgrave, Vic.—The shire council is anxious for the electricity commission to give electric supply in the district. Owing to the scattered nature of settlement, however, the commission considers that the capital cost would be excessive in proportion to the load. But the council states that it would be prepared to guarantee an income that would cover expenditure, and it wishes the commission to prepare estimates for the scheme.

Murtoa, Vic.—The Dunnmunkle shire council has voted a bonus of £25 to the engineer in charge of the Murtoa electric supply undertaking, Mr. J. R. Watson, in recognition of his able administration.

Nambour, Q'ld.—Plans for an electric supply scheme are being drawn up. Mr. T. W. Bridger is the consulting engineer.

Nyngan, N.S.W.—Messrs. A. C. F. Webb and Burgess, consulting engineers, Sydney, are inviting tenders, closing Nov. 19, for services in connection with the local electricity supply scheme.

Ouyen, Vic.—The Walpeup shire council has received a report from Mr. Perry, electrical engineer at Mildura, recommending considerable extensions to the electric supply plant.

Portland, N.S.W.—The Blaxland shire council's electric supply undertaking was officially inaugurated on October 17. Energy is purchased in bulk at 550 volts from the Commonwealth Portland Cement Co., and stepped down to 415/240 volts, 50 cycle three phase, for distribution, by means of two 75 kv.a. transformers installed in an out-door substation. Street lighting is effected by means of G. E. Novalux pendant units suspended from wrought iron brackets. The whole of the equipment was supplied and the installation work carried out by the Australian General Electric Co. The town is an important industrial centre, with population of 5,000 and unimproved capital value of £57,000. The cost of the

present scheme is £5,000 and a further £3,000 loan for extensions is to be raised.

Port Pirie, S.A.—The town council has decided to reduce the price of electrical energy for lighting from 9d. to 8d. per unit. There are now approximately 2,000 consumers on the mains.

Rangiora, N.Z.—A proposal is on foot to form a power board to give supply in the counties of Rangiora, Ashley, Oxford, Eyre and Kowai, in Canterbury province.

Ringwood, Vic.—The state electricity commission recently took over from the borough council the retailing of electricity in the district, under an agreement which stated, inter alia, that the cost of energy supply to individual consumers was to be in no way increased. The council now alleges that, under the new two-part tariff, the unit cost to many consumers has been increased, and it has called upon the commission to honor its agreement. The commission in reply, has offered to revert to the tariffs formerly in force, but the council evidently considers this unsatisfactory, as it has placed the matter in the hands of its solicitors.

Ross, Tas.—A proposal has been under discussion to obtain power supply from the hydroelectric department for the municipalities of Oatlands, Campbell Town and Ross as an associated group or power board. Owing to lack of support from householders, however, the council of the last-named town finds that it cannot go on with the scheme. The other municipalities are nevertheless pushing on with the preliminary enquiries and propose to submit the matter to the ratepayers by holding polls. The hydroelectric department requires a guarantee of £2,250 per annum to ensure the scheme being a paying concern.

Sorrento, Vic.—The Flinders shire council intends to install meters on its electric supply system instead of charging the present flat rate.

Stawell, Vic.—The borough council is borrowing £3,500 for extensions to the electric supply undertaking.

Stratford, Vic.—The Avon shire council is endeavoring to get the electricity commission to extend electric supply to the town from the Gippsland transmission scheme via Maffra. Just at present, however, the commission is unable to take action owing to lack of funds, and also because the position with regard to supplying towns beyond Stratford is uncertain. The question of what other towns are to be supplied influences the type of line to be run to Stratford.

Swan Hill, Vic.—The electric supply department of the municipal council shows a profit of £500 on its operations over the last twelve months. A reduction in the price of energy for domestic requirements is impending.

Tailem Bend, S.A.—The district council is negotiating with the railway department for electric supply by the latter.

Takaka, N.Z.—The Golden Bay power board proposes to develop hydroelectric power from the Pu Pu stream at a cost of £80,000. The estimated running cost of the scheme is £9,350 and a revenue of £11,500 is anticipated.

Te Aroha, N.Z.—The half-yearly balance sheet of the Thames Valley power board shows a credit balance of £806. The total revenue amounted to £38,131, the cost of power was £11,785, interest and sinking fund amounted to £19,500, and administration and maintenance totalled £6,040. The total number of consumers, including those in the boroughs of Te Aroha and Thames, which purchase energy in bulk, is 5,264.

Violet Town, Vic.—Mr. Fosdick, electrical engineer in charge of the municipal electric supply undertaking, has tendered his resignation.

Wagga, N.S.W.—The municipal council is obtaining the services of a consulting engineer to report on the proposed linking-up with the public works department's Burrinjuck hydroelectric scheme.

Waipukurau, N.Z.—The electric supply from the Mangahao hydroelectric station of the public works department to the Central Hawke's Bay power board has been switched on. Energy at 110,000 volts is received at a main substation of the outdoor type at Onga, and stepped down to 11,000 volts for primary distribution. Further stepping down is effected at distribution substations throughout the area, to the final pressure of 400/230 volts, three phase. At present the board gives supply to about 960 consumers.

Wallaroo, S.A.—The town council is making a reduction in the lighting tariff from 9d. to 5d. per unit. The Wallaroo Mt. Lyell Fertiliser Co., which supplies energy in bulk to the council, has agreed to reduce its charge from 6d. to 4d. per unit.

Wangaratta, Vic.—The council is reluctant to hand over its electric supply undertaking to the electricity commission for operation as part of the north eastern district supply scheme. The council realises that it will lose a profitable enterprise, and fears that under the commission the service may not be so satisfactory.

Wellington, N.Z.—Now that the Mangahao bulk supply is available and the Evans Bay power station in working order, the old electric supply plant in Harris street is being dismantled. The first of the Parsons turbine sets has been transferred to Evans Bay, and the second will follow shortly. The question of the utilisation of the Harris street site has given rise to some discussion, as the property is centrally situated and, therefore, valuable. The 1920 loan schedule of the city council made provision for the establishment of municipal hot baths when the electric supply station was removed, but it is not altogether certain that this proposition will be gone on with. The Mangahao supply is now giving satisfaction and the Evans Bay station is doing good work at peak load periods.

West Wyalong, N.S.W.—Additions have been made to the shire council's electric supply plant at a cost of £6,000.

Yass, N.S.W.—Messrs. Crompton and Co. are carrying out the installation of an electric supply plant. Energy will be generated by a 70 kw. crude oil alternator set, and the distribution will be at 415/240 volts, 50 cycle three phase.

Current Prices for Electrical Supplies

The quotations in this list represent the average retail selling prices ruling in Melbourne during the month of publication. These prices are subject to bona fide traders' discounts. Special rates are obtainable in most cases for large quantities. In general Sydney prices are slightly lower.

Adaptors—

Hardwood	doz.	12/6
Parallel	each	6/6

Blocks—

3 in. round	gross	22/6
3½ in. round	gross	25/-
6 in. x 3 in. rectangular	doz.	6/3
9 in. x 3 in. rectangular	doz.	7/6
6 in. x 6 in. square	doz.	12/6

Bushes—

½ in. ideal metal	gross	7/6
¾ in. ideal metal	gross	7/6
1 in. ideal metal	gross	8/9
1 in. plain wooden	doz.	1/6
2 in. plain wooden	doz.	1/8
1 in. plain wooden	doz.	2/-

Bells and Bell Material—

Bell transformers	each	10/6
1½ volt dry cells	each	3/-

Bells and Bell Material—

Bell wire—1/.029 d.c.c.	1,000 yd.	32/6
1/.036 d.c.c.	1,000 yd.	42/6
1/.029 d.c.c. and i.r.	1,000 yd.	50/-
1/.036 d.c.c. and i.r.	1,000 yd.	60/-
No. 2 porous pots	each	2/-
No. 2 jars	doz.	8/9
No. 2 zincs	each	1/3
Salammoniac	lb.	1/3
2½ in. wood box bells	each	4/6
2½ in. iron box bells	each	4/6
3 in. wood (church gong)	each	18/4
Bell presses	from each	3/9

Pocket Lamp Batteries—

Batteries, pocket lamp	each	1/10
2-cell batteries	each	2/5
3-cell batteries	each	2/8

Ceiling Roses—

	English	Japan
2-plate	doz. 12/1	6/3
3-plate	doz. 15/-	8/9

Connectors—

1-way, porcelain	doz.	2/6
2-way, porcelain	doz.	4/-
3-way, porcelain	doz.	5/-

Counterweights—

Porcelain	each	2/6
Brass	each	5/6
Shot for same	lb.	6½d.

Casing and Cover—

Best white pine	100 ft.	10/-
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Conduit—

		Plain	Screwed
½ in.	100 ft.	9/2	20/-
¾ in.	100 ft.	10/-	20/-
1 in.	100 ft.	15/-	57/6
1 in.	100 ft.	27/6	40/-
1½ in.	100 ft.	45/-	60/-
2 in.	100 ft.	68/-	85/-
2 in.	100 ft.	—	135/-
¾ in. oval	100 ft.	12/6	—

Conduit Fittings—

		½ in.	¾ in.	1 in.
Grip—Tees	doz.	3/6	3/6	4/3
" Elbows	doz.	2/9	2/9	3/6
" Couplings	doz.	2/3	2/3	2/9
Crampets	gross	5/5	5/5	6/3
Saddles	gross	5/-	5/-	5/5
Screwed tees	doz.	5/5	7/6	—
" elbows	doz.	3/9	5/5	—
" couplings	doz.	2/9	4/-	—
" bell mouths	doz.	5/-	5/-	—
" " " 1 in.	doz.	14/10	—	—
" " " 1½ in.	doz.	19/6	—	—
" " " 1½ in.	doz.	27/-	—	—

Junction Boxes—

		½ in. & ¾ in.	1 in.
2-way	doz.	10/10	10/10
3-way	doz.	11/3	11/3
4-way	doz.	11/3	11/3

Fuses (Cut-outs)—

	British	Japan
5 amp, anchor type doz.	10/	5/
5 amp, round chamber doz.	17/6	8/9
8 amp, round chamber doz.	20/	12/6
10 amp, oblong doz.	35/	25/
20 amp, oblong each	—	3/

Holders—

	English	Japan
C/G., S/C. holders doz.	12/6	8/9
½ in. and ¾ in. holders doz.	12/6	8/9
Batten holders doz.	13/9	10/

Lamps—

Metal Filament, Vacuum Type		
25 to 250 volts, 20 to 60 watt each	2/	
20 to 250 volts, 100 watt each	5/	

Gas-filled Type		
20 to 250 volts, 25 to 40 watt each	2/9	
60 watt each	3/3	
75 watt each	3/9	
100 watt each	5/3	
150 watt each	7/	
200 watt each	9/	
300 watt each	13/	
500 watt each	17/6	
750 watt each	22/6	
1000 watt each	27/6	
1500 watt each	40/	

Carbon Filament		
All voltages, 5 to 32 candle power doz.	24/	
All voltages, 50 candle power doz.	42/	

Plugs—

5 amp two pin plugs doz.	30/
5 amp two pin tops doz.	15/

Shades, Opal—

8 in. doz.	11/3
9 in. doz.	17/6
10 in. doz.	21/3

Switches—

	English
5 amp s.p. pol. brass doz.	17/6
5 „ s.p. ox. copper doz.	19/3

Switches—

	English
5 „ 2-way pol. brass doz.	30/
5 „ 2-way ox. copper doz.	33/
10 „ s.p. pol. brass doz.	37/6
5 „ d.p. pol. brass doz.	40/
10 „ d.p. pol. brass doz.	85/
5 „ s.p. ceiling switches each	5/6
5 „ 2-way ceiling switches each	7/6
1 „ ceiling switch and rosette each	5/6
3 amp American tumbler doz.	24/
3 „ s.p. indicating rotary doz.	24/
3 „ s.p. non-indicating rotary doz.	22/6
3 „ 2-way rotary doz.	56/3
5 „ d.p. indicating rotary doz.	62/6
10 „ d.p. indicating rotary doz.	78/
20 „ d.p. indicating rotary doz.	150/

Switchboards—

	English	Japan
Single circuit marble 5 amp each	9/9	8/
Single circuit marble 10 amp each	17/6	16/3
Two circuit marble 5 amp each	19/2	15/10
Two circuit marble 10 amp each	25/	22/

Switchboard Frames—

6 in. x 6 in. local make doz.	9/6
6 in. x 8 in. local make each	1/
8 in. x 8 in. local make each	1/3
8 in. x 10 in. local make each	1/6
10 in. x 10 in. local make each	1/8

Tape—

Black adhesive lb.	2/9
Pure rubber lb.	10/

Wire and Cables—

	Per 1,000 yd.
1/.044, 600 meg.	£7 3 4
1/.064, 600 meg.	10 5 0
3/.036, 600 meg.	11 15 0
7/.036, 600 meg.	20 10 0
7/.044, 600 meg.	26 0 0
7/.064, 600 meg.	43 10 0

Flexibles—

	Per 100 yd.
23/.0076 cotton	£2 5 0
40/.0076 cotton	2 16 8
70/.0076 cotton	3 11 8
110/.0076 cotton	4 13 4

Electrical Contracts

COMMONWEALTH

Department of Works and Railways.—Installation of electric light and power in Hamilton (N.S.W.) drill hall and gun park—E. H. Edmunds; installatoin of passenger lift at parcels office, P.O., Melbourne—Hoey and Loft Pty. Ltd.

Motors for telephone exchange, Albion, Queensland—Noyes Bros. (Sydney) Ltd. Two motors, Jervis Bay.—Siemens Bros. Ltd.

Federal Capital Commission.—Electric light and power installation—Stacey and Co.; installation of electric light and power equipment to 30 cottages, Canberra—F. McPherson and G. W. Hammett.

P.M.G.'s Dept., General.—3,500 bell boxes—British General Electric Co. Ltd.; 3,000 magneto generators—Ericsson Telephone Manuf. Co.; high frequency measuring apparatus—Western Electric Co.; One No. 3 public address system, consisting of 1 microphone, 1 amplifier and 1 projector—Western Electric Co.; 250 strips of protectors in strips of 20 pairs, and 33 strips of protectors in strips of 10 pairs—Cook Electric Co.

P.M.G.'s Dept., South Australia.—320 relays and 182 individual dustproof covers for relays—British General Electric Co.

P.M.G.'s Dept., Victoria.—Insulators—R. Fowler Ltd.; Firebrick Insulator and Pottery Co. Pty. Ltd.; Calyx Porcelain Co. Ltd.; telephones, all states—Ericsson Tel. Mfg. Co.; transformers—Western Electric Co. (Aust.). Ltd.; conduits, earthenware—The Adelaide Pottery and Drain Pipe Works Ltd.; McHugh Bros. Pty. Ltd.; Albion Pottery Works; R. Fowler Ltd.; Speares Tempe Brick, Tile and Pipe Works Ltd.; The Sydney Stoneware Pipe Association Ltd.; Lithgow Valley Colliery Co. Ltd.; E. A. Hughes.; transformers—B.W. Electric Co. Ltd.; insulators—Telephone Radio and Electrical Supply Co.; insulators—Bullers Ltd. 2 secondary batteries, each with 25 cells—Automatic Telephones Ltd.; 298 relays and 10 visual signals—Automatic Telephones Ltd.

P.M.G.'s Dept., West Australia.—Creed apparatus—Amalgamated Wireless Co.

STATES

N.S.W. Public Works.—Installation of electric light, Bathurst district hospital—J. B. Kidd; three 100-kv.a. transformers for Yass water supply—Electrical Plant Manufacturers Ltd. Installation of electric light, Campbelltown court house, J. B. Kidd; installation of electric light, Bathurst experimental farm, J. B. Kidd.

N.S.W. Railways Dept.—Steel roller shutters for Sutherland substation and White Bay power house—Austral Roller Shutter Works Ltd.; 4 feed water meters for White Bay—Australian General Electric Co. Ltd.; equipment for Lakemba (Belmore) and Gordon substations—Australian General Electric Co. Ltd.; electric travelling jib crane, White Bay power house—Gibson, Battle and Co. Ltd.; 66 type D.K. 83a 55 h.p. traction motors, ditto, 6 type D.K. 83a traction motors—English Electric Co.; 50 No. 9 type bogie tramway trucks, 25 "P" type tram cars—Meadowbank Manufacturing Co.; 10 3-kv.a. and 5 7½-kv.a. transformers—Electrical Manufacturers Ltd.; rectifier equipment for Gordon—Gibson, Battle and Co. Ltd.; two 3,000-kw. rotary converter units and 2 sets starting switchgear, 6 single phase transformers—Australian General Electric Co. Ltd.

Public Works Dept., Victoria.—Installation electric lighting at nurse's block, Sunbury hospital for insane—McDonald and Co.; installation electric power points, alterations, etc., switchboard and motor, observatory, Melbourne—McDonald and Co. Installation electric lighting and power points and fittings, Horsham high school—Ryan and Wilsmore; five motors to workshop, Pentridge penal establishment—McColl Electric Works Pty. Ltd.

State Electricity Commission of Victoria.—Insulator pins—McPherson's Pty. Ltd.; galv. steel work for Rubicon "A" Sugarloaf and Benalla substations—Ed. Campbell and Son; hinged expulsion fuses—Metropolitan-Vickers Aust. Pty. Ltd.; elect. motor driven hoists—A. Goninan and Co.; disconnecting switches—Metropolitan-Vickers (Aust.) Ltd.; service connectors—Purvis-Glover Eng. Co. Ltd.; switchgear and accessories—Ferguson, Pailin Ltd.; 3,000-kv.a. transformers and spares—Johnson and Phillips Ltd.; 6,000 V. disconnecting switches—Metropolitan-Vickers Aust. Pty. Ltd. Lighting arresters—Aust. Westinghouse Elect. Co. Ltd., £898/4/-; item 2, lightning arresters—Aust. General Elect. Co. Ltd., £553/10/-; item 3, varnished cambric cable—Metropolitan-Vickers Elect. Co. Ltd.; disconnecting switches—Metropolitan-Vickers Aust. Pty. Ltd.; leadplate storage battery—Tudor Accumulator Co.

Victorian Railways.—Electrically operated lift equipment for automatic elevator—Waygood Otis (Aust.) Pty. Ltd.; plain lead covered dry core telephone cable—British Insulated and Helsby Cables Ltd.; self-contained portable petrol driven electric welding plant—Robt. Bryce and Co. Pty. Ltd.; electrodes—Robt. Bryce and Co.; overhead electrical equipment—British Insulated and Helsby Cables Ltd.; line relays—McKenzie and Holland (Aust.) Pty. Ltd.; hard drawn copper strip—British Insulated and Helsby Cables Ltd.; manganese steel, Electric street railway and electric tramway crossing—Hadfields (Aust.) Ltd. Direct current generator—Crompton and Co. Ltd.; lightning arrester, 3 phase, outdoor 20,000 volts—Australian Westinghouse Electric Co.; hard drawn copper strip, hard drawn bare copper cable—British Insulated and Helsby Cables Ltd.; electric storage battery with accessories and spares—Tudor Accumulator Co. Ltd.; copper plates—Gilbert Lodge and Co. Ltd., Wm. Adams and Co. Ltd.; lightning arresters, 3 phase, outdoor 20,000 volts—Australian General Electric Co.

Vic. State Coal Mine.—Lamps, electric, 60 watt, 240 volts—Wm. McLean and Co.; magneto mine exploders—Lawrence and Hanson Elec. Co.; shot firing cable—Henley's Telegraph Works Pty. Ltd.; knife switch contacts—Metropolitan-Vickers Elec. Co. Three 5-h.p. induction motors, also 6 starters for same—Metropolitan-Vickers Elect. Co.

GENERAL

Brisbane Tramway Trust.—Lubricating oils and compounds—John Fell and Co., Vacuum Oil Co., Texas Oil Co.; filament lamps—Edison Swan Electric Co., and the E.S.C.A.; trolley wire (10 miles)—Wm. Adams and Co.

Byron Shire Council, N.S.W.—Ironwork for poles—Lowe Bros.; porcelain insulators—Canney and Towe; insulated cables—W. T. Henley's Telegraph Works Co. Ltd.; street lamps and brackets—Australian General Electric Co. Ltd.; distribution boxes—Fred. S. Lee Ltd.; service cutouts—W. T. Henley's Telegraph Works Co. Ltd.; outdoor service cutouts—Edison-Swan Electric Co. Ltd.; consumer's meters—Noyes Bros. (Sydney) Ltd.; time switches—British General Electric Co. Ltd.; measuring instruments—H. Rowe and Co.

Melbourne City Council.—400 castings for house cut-out boxes—The Dawn Manufacturing Co. Pty. Ltd.; 3,000 house cut-out boxes—Fred. S. Lee Ltd.; 200 enamelled iron shades—The Lawrence and Hanson Electrical Co. Ltd.; 2,000 glazed porcelain saddle pieces—Drayton Bros.; 200 suspension contactors, complete with hoods and suspension clamps—Messrs. Johnston and Ashton; 1 3-in. boiler feed meter—Gibson, Battle (Melbourne) Pty. Ltd.; 41 direct current meters—Messrs. Homewood and O'Neill; 27 current transformers—Metropolitan-Vickers Electrical Co. Ltd.; one recording watt meter—H. Rowe and Co. Reconditioning of four 1,500-kw. rotary converters and removing equalisers from commutator end to booster end of armature—Weymouths Ltd.; soot blower equipments complete for boiler house plant—A. Walker; cast iron transformer chamber, with three current transformers—A. Reyrolle and Co.

Sydney City Council.—33,000-volt lead covered cables—Noyes Bros. (Sydney) Ltd.; maximum demand indicators—Edison Swan Electric Co. Ltd.; overhead service fittings—G. Compton; fibre conduits—Western Electric Co. (Aust.) Ltd.; l.t. shackle insulators—New South Wales Insulator Works; transformer oil—Vacuum Oil Co. Pty. Ltd.; copper bus-bars—Noyes Bros.

Williamstown City Council, Vic.—H.T. cable—Johnson and Phillips Ltd.; switchgear—Reyrolle and Co.

NEW ZEALAND

Christchurch City Council.—Up to 4,000 meters, to be delivered in instalments over a year—Carrick Wedder- spoon Ltd.; air break switches for extension of 11,000-volt system—Canterbury Engineering Co.

New Zealand Railways.—Motors and starters for Petone workshops—National Electrical and Engineering Co. Ltd.; Metropolitan-Vickers Ltd.; A. S. Paterson and Co. Ltd.; Cory-Wright and Salmon Ltd.; National Electrical and Engineering Co. Ltd.

Waitemata Electric Power Board.—Meters—A. D. Riley and Co.

TENDERS OPEN

COMMONWEALTH

P.M.G.'s Dept., General.—Nov. 17—Junction material, magneto. Dec. 1—Motor generators. Dec. 15—Junction apparatus for manual exchanges. Dec. 22—Accumulators and C.E.M.F. cell batteries. Dec. 29—Magnet and resistance wire. March 2—Condensers. March 9—Telephone cord circuit relays, instrument cords. March 16—Ringing generators and polechangers, power board equipment, Adelaide exchange.

STATES

N.S.W. Public Works Dept.—Nov. 23—Switchgear. Nov. 30 (extended)—Metering equipment for substations; Kiama-Nowra transmission line and Barren Jack hydro-electric development. Feb. 1—Two 3-ton electrically driven pedestal jib cranes.

N.S.W. Railways and Tramways.—Dec. 16—Ten 1,800-kv.a. single phase transformers; 2,200-volt ironclad switchgear. Dec. 23—Air cooler. Jan. 13, 1926—Four 3,000-kw. rotary converter units; 1,000-kv.a. transformer. Jan. 20—100 40-h.p. traction motors, two 500-kw. rotary converter units. Jan. 27—Two 500-kw. converter units. Feb. 17—1,500-volt d.c. switchgear. March 10—Stokers or pulverised fuel equipment.

South Aust. Supply and Tender Board.—Nov. 18—100 telephones, insulated lead covered cable, fittings for telephones. Nov. 25—Two electric hoists.

State Electricity Commission of Vic.—Nov. 23—Wood stave pipe; ironclad service fuses. Dec. 14—22,000-volt insulators. Dec. 29—1,000 kv.a. transformers. April 12—Spec. 26/1 turbo-generators, transformers, switchgear, cranes and accessory plant for Sugarloaf-Rubicon hydroelectric scheme.

Victorian Country Roads Board.—Nov. 23—Portable internal combustion power plant.

Victorian Railways.—Nov. 18—Aerial telephone cable. Nov. 25—Air brake equipment. Dec. 9—Insulated copper wire, lighting and power switchboard, fibre. Jan. 13—Portable double recording watt meter. Jan. 20—Automatic battery charging equipment. Jan. 27—Power totaliser and transmitter, total power recorder, and total power indicator.

Victorian State Coal Mine.—Nov. 23—Bitumen covered cable. Nov. 25—Cables, junction boxes and switch pillars.

Victorian State Rivers and Water Supply Commission.—Nov. 18—10-h.p. crude oil or kerosene engine. Dec. 4 (extended)—360-b.h.p. quick revolution steam engine and water tube boiler.

GENERAL

Australian Steamships Pty. Ltd., Melbourne.—Dec. 1—Electrical supplies and engineers' supplies for 12 months. **Balranald Municipality, N.S.W.**—Dec. 5—Crude oil engines, generators and equipment required for town lighting (see advt.).

Melbourne and Metropolitan Tramways Board.—Dec. 8—Ten two-motor equipments, air brake equipments. Dec. 22—Four-motor equipments and air brake equipments.

Melbourne City Council.—Nov. 23—(Extended), 5,000-kw. turbo-alternator.

Metropolitan Water Sewerage and Drainage Board, Sydney.—Dec. 3—Centrifugal pumps and electric motors, electric storage battery locomotives. Jan. 7—Two 500-h.p. a.c. motors, starters and spares.

Municipality of Narrabri, N.S.W.—Dec. 31—Two Diesel or semi-Diesel engines, generators, switchboard, etc., for town electric supply.

Newcastle City Council.—Dec. 7—Four constant current moving coil transformers and control equipment, one 1,000-kv.a., one 200-kv.a., and two 100-kv.a. transformers.

Nyngan Municipal Council, N.S.W.—Nov. 19—Electric supply scheme.

Sydney City Council.—Nov. 16—Tungsten filament lamps. Dec. 4—Insulating tape, impregnated paper tubes, impregnated teak laths. Dec. 14—H. and L.T. switchgear and rotary converters, L.T. pilot cable, H.T. underground cables. Feb. 1—Steam turbo-alternator plant, automatic reclosing equipments for H.T. feeder switches. Feb. 8—Steam raising plant. Feb. 22—Power house switchgear.

Toowoomba City Council, Qld.—Dec. 5—25,000-gal. and 20,000-gal. pumping plants.

NEW ZEALAND

Auckland Electric Power Board.—Feb. 8—Overhead cotton covered cable. Feb. 22—Cutouts.

Christchurch Drainage Board.—Jan. 5—Three electrical centrifugal sewage pumping plants.

Hastings Borough Council.—Feb. 1—500 b.h.p. Diesel engine, and alternating current generator.

Public Works Dept.—Nov. 24—Two neutral earthing reactors. Dec. 8—Transmission steel supports. Jan. 19—50,000-volt switchgear, section 141, synchronous condenser, section 176. 110,000-volt switchgear. Jan. 26—50,000-volt switchgear, section 139. 11,000-volt switchgear. Four 4,000-kv.a. transformers, 50,000-volt lightning arresters. Feb. 16—Outdoor switchgear, Waikato scheme.

Takapuna Tramways and Ferry Co. Ltd.—Dec. 31—Rolling stock equipment, substation equipment, overhead equipment, rail bending, etc.

MUNICIPAL COUNCIL OF SYDNEY.

STEAM RAISING PLANT

TENDERS will be received by the undersigned until 3 p.m. on the 8th February, 1926, for the SUPPLY and DELIVERY of STEAM RAISING PLANT in accordance with Specification No. 964.

SPECIFICATIONS and full particulars may be seen at the Office of the Construction Engineer, Electricity Department, Town Hall, Sydney, and copies may be obtained from the same Office by the payment of the sum of ten shillings and sixpence (10/6) direct into the City Treasury, Town Hall, Sydney, which sum will be refunded upon the receipt of a bona fide tender.

The lowest or any tender not necessarily accepted.

TENDERERS please note that they must pay their cash deposit direct into the City Treasury, Town Hall, Sydney, and NOT enclose it with their tender, otherwise their tender will be rejected as informal.

W. G. LAYTON, Town Clerk.

Town Hall, Sydney, 18th September, 1925.

EFFICIENT HYDRO ELECTRO PLANT FOR SALE.

Owing to the recent enlargement and rearrangement of the Tauranga Borough Council's generating station it has now available for disposal:—

2—Escher Wyss Francis turbines of 150 H.P. (maximum, running at 750 r.p.m. under 108 feet head, complete with modern oil governors, main valves and draught tubes coupled by flexible coupling, to:—

2—Brush Co's. 100 KV.A. (at 40 deg. C.), 50 cycle 3 phase, 400 volt star connected alternators complete with direct connected exciters, also main, and shunt rheostats.

The above plant has given consistently fine service since its installation in 1915.

The Council invites enquiries and will undertake delivery F.O.B. Tauranga, N.Z.

MUNICIPALITY OF BALRANALD

TENDERS—ELECTRIC SUPPLY DEPARTMENT

TENDERS endorsed 'ELECTRICAL MACHINERY AND APPARATUS,' and addressed to the Town Clerk, Balranald, will be received up to the 5th December, 1925, for the following sections:—

- (1) Crude Oil Engines.
- (2) Dynamos, switchboard, electric pump.
- (3) Cables.
- (4) Belting.
- (5) Meters.
- (6) Sundry apparatus.

PLANS AND SPECIFICATIONS may be had upon application to A. C. BERTOLI, POWER HOUSE, CHARLTON, VICTORIA, for which a fee of £1/1/- (by cheque) will be charged and which sum will be refunded upon receipt of a bona-fide tender.

The lowest or any tender not necessarily accepted.

L. G. REID, Town Clerk.

Council Chambers,
Balranald, N.S.W.,
4th November, 1925.





Editorial





THE POWER FACTOR PROBLEM

The numerous disadvantages of poor power factor are too well known to need any recapitulation. Suffice it to say that the presence of wattless current imposes a very severe burden upon the electric supply industry, resulting in cost of service being higher than need be. It is generally recognised that the poor power factor in present distributing systems is to a very large extent the result of the almost universal application of induction motors. Such motors, while excellent power machines, have the disadvantage of drawing a rather large magnetising current which is frequently equal to, or even larger than, the working current.

The principal types of apparatus that have been used for counteracting these wattless currents are:—(1) synchronous condensers, (2) static condensers, (3) phase advancers, (4) synchronous motors, (5) synchronous-induction motors. In the absence of more suitable apparatus, equipment of each of these types has proved very valuable in its particular sphere, but the solution of the problem is not by any means complete. For instance, the use of condensers or phase advancers for supplying leading current to counteract the wattless current drawn by induction motors undoubtedly effects remarkable economies, but after all, seeing that the real trouble is in the motor, it is only side-tracking the difficulty. Were an induction motor available that would operate at unity power factor the condenser would be unnecessary. It is not intended to depreciate the value of condensers, either synchronous or static, for power factor correction, but merely to point out that their use in conjunction with induction motors is, at best, a compromise with conditions. There are many fields apart from the application to induction motors where condensers are indispensable if true economy is desired.

The root of the trouble being in the motor it is the motor design that should be tackled in order to effect a remedy. In the endeavor to arrive at a solution the synchronous and synchronous-induction motors have been introduced, but, although work along this line is movement in the right direction, it is unfortunate that each type of machine is limited in its field. The synchronous motor has the admirable characteristic not only of operating at unity power factor, but of being able to supply leading magnetising current which will neutralise wattless current in the distribution system. Such a motor, operating without mechanical load,

constitutes a synchronous condenser. Unfortunately, however, this motor is limited in its field of operation for power purposes. It has poor starting characteristics, and it falls out of step when loaded beyond a certain fairly low overload, depending upon the design of the machine. There is also the drawback that a separate supply of direct current is required for excitation. A considerable advance was made, however, when the synchronous-induction or auto-synchronous motor was developed. As its name implies, this machine combines the characteristics of the synchronous and induction types of motor, starting as an induction motor and running as a synchronous motor. But although it has excellent features as regards starting, power factor, and standing up to overloads, its field appears to be limited to large power applications, as it has the disadvantage of requiring separate excitation. It is evident, then, that neither of these types supplies the universal solution of the power factor problem.

The ideal a.c. motor would have the good starting and overload characteristics of the polyphase induction motor, combined with the excellent running qualities of the synchronous motor as regards power factor and constancy of speed. The first cost of the motor with starting apparatus should not greatly exceed that of an induction motor of similar capacity, and the type should be capable of economical application over a very wide range of powers. Claims of fulfilling these requirements are made for the Fynn-Weichsel motor, which is now being put on the market in the United States. It is stated that it has "a running performance better than that of a standard synchronous motor, starting performance as good as the best type of induction motor, and an admirable ability to synchronise automatically when going from starting to running operation." A description of this machine and the principles involved in its operation is published on another page. The performance claims appear to be substantiated in practice, and the new development should have very far-reaching effects.

The whole matter hinges on the question of price. The average small power user is apt to buy his motors on price alone. If a squirrel cage motor will do the work, that motor goes in. The consumer will not give a thought to the disadvantage to the supply authority, which comes back to himself in the form of higher power charges, unless the supply authority gives him an inducement to think about the matter. This inducement can be given in the form of a

grading of tariffs according to the power factor of the load. Many supply authorities do this, and there has been marked benefit to both supplier and consumer where such apparatus as static condensers or synchronous-induction motors has been installed. But with this new motor available the power factor clause in tariffs should be made universal. The price of a Fynn-Weichsel motor is slightly higher than that of a slip-ring induction motor of similar capacity, and it is almost certain, therefore, that power users will not install the new motors unless the tariff is such that their operating costs will be reduced by the use of the power factor correcting machine. The same, of course, applies in the case of condensers or synchronous-induction motors used for power factor correction. But the difference in price between the ordinary and the new motor is considerably offset for large installations by the fact that it is not necessary to have only Fynn-Weichsel motors running in order to obtain unity power factor. With proper selection of capacities and service Fynn-Weichsel motors can be run in parallel with ordinary induction motors so that the leading magnetising currents of the one group will neutralise the lagging currents of the other. With the variety of power factor correction apparatus now available, and the fact that its use can result in actual overall economy to the consumer, the responsibility for poor power factor on distribution systems has largely been moved back on to the shoulders of the supply authorities.

YALLOURN AGAIN

A statement in connection with the Yallourn undertaking of the Victorian electricity commission is promised at an early date by Mr. Eggleston, the minister in charge of the undertaking. No indication is given as to whether any change in policy is contemplated, or whether it will simply be an official reply to criticisms. So far the ministry has been unable to secure the services of an expert to report on the undertaking, but Mr. Eggleston expects that an appointment will be made very shortly. The latter announcement is not a matter for surprise. It is hardly likely that any engineer in the southern hemisphere would consider himself a sufficient authority on all the phases of the Yallourn enterprise to sit in judgment and make recommendations as the result of his enquiry, or, if he did, would they be acceptable to the taxpayers? It is understood that oversea experts have been approached, and if they have any knowledge of the scheme their hesitancy to act as a commission of enquiry is readily understood. Such an enquiry is a tall order for any one man; it calls for an electrical engineer who

has had experience with large generating plants and high tension transmission lines; it also requires an engineer with experience of low grade fuels; and, what is most important, an engineer with practical experience in excavation and the handling of large quantities of material. Furthermore, the appointee must needs be a man of sound commercial training, able to dissect costs of, say, the briquetting plant, and to advise the government in regard to the wisdom, or otherwise, of continuing and extending the retail distribution of energy throughout Victoria.

Yallourn continues to be one of the liveliest topics in Victoria. The public is alarmed at the huge expenditure, and the end is not yet. Several millions of additional capital must be provided to complete the schemes to which the commission is already committed. The amount includes one million on the Sugarloaf-Rubicon hydroelectric scheme, from which a maximum output of 25,000 kw. (which is not necessarily a continuous supply) is estimated to be obtainable. The disappointment behind the public's attitude is undoubtedly the fact that the promise of cheap energy has not eventuated; as a matter of fact, energy generated from Newcastle coal in a modern station on the seaboard, would be cheaper. On the other hand, the development of the brown coal asset is an advantage to the state, especially in view of the frequent strikes that are a feature of the New South Wales coalfields, on which Victoria has heretofore been dependent for black coal.

The annual report of the state electricity commission for the year ended June 30 has been issued and is reviewed on another page. In answering a criticism that the report was not sufficiently informative, Mr. Eggleston stated that "the balance sheet contains all the particulars that the act provides that a private company should give." That is a very lame excuse to offer. It is well known that companies give as little information as they can in their reports and balance sheets, so the minister insinuates that the commission has adopted the same policy. Such a policy may be justifiable under some circumstances, but Yallourn has no competition to fear, and all the citizens are shareholders, so there is no reason why the fullest publicity should not be given in regard to its affairs. For instance, the present report contains no statement as to the cost of mining coal, the cost per unit of generating energy at Yallourn, or the figure at which energy is charged to the retail distribution systems. The balance sheet shows that the commission's losses to date amount to £912,328, including £514,642 interest on capital during construction, and an item of £62,023 charged against the commission by the treasury.

Notwithstanding this the commission is satisfied that when its undertakings are in full swing

the investment will be more than justified. The commission certainly has it in its power to get a return on the capital expended, but this means that the public must pay, and high rates for energy will retard the industrial progress anticipated as a result of the development of the wonderful brown coal deposits. The report as it stands is unsatisfying; it does not give the information one has a right to expect. It is impossible for anyone without inside information to glean the actual position of the undertaking. The first reform that should be effected is the separation of the generating and distribution departments. To do this there is no need for the government to await the report of the expert who has yet to be appointed and whose report may not be ready for six months.

ELECTRICAL DEVELOPMENT

The Sydney city council some time ago agreed to co-operate with the electrical traders in an educational publicity scheme. The idea was to raise a fund of £10,000 per annum for three years, of which the council would subscribe at least half and the traders make up the remainder. When the arrangements were approaching finality the question was raised as to whether the council had the power to subscribe money for such a purpose, and this hung up the scheme. Now, Mr. H. R. Forbes Mackay, the city electrical engineer, who was a warm supporter of it has gone to London in connection with the new power station. The electricity supply committee recently instructed Mr. S. Y. Maling, the acting general manager, to report on the matter. It is understood that his report stated that the two alternatives were, firstly, the scheme of Mr. Mackay to co-operate with the private traders, or, secondly, for the city council to act independently. The committee thereupon instructed Mr. Maling to proceed with a publicity scheme and to arrange for public demonstrations of electrical equipment. Furthermore it expressed itself in favor of the city council selling equipment direct to consumers and installing same either on a cash basis or on deferred terms. Legislation will be necessary to empower the council to enter the trading field, and whilst the council, having a large labor majority, may favor the recommendation of the electricity supply committee, it is not by any means certain that such legislation will meet with parliamentary approval.

The entry of municipalities into the trading field has always met with strenuous opposition, and rightly so. It introduces an element of unfair competition as there is a tendency to sell goods at lower prices than those at which reputable houses could afford to trade and at the same time meet overhead charges. Further-

more, it means that the council is entering into competition with its own ratepayers. The first duty of an electrical supply undertaking is to generate and sell energy as cheaply as possible, and when this is done the traders can be relied on to push the sale of apparatus. The proposal of Mr. Forbes Mackay to co-operate with the traders was a sound scheme which promised to be of mutual benefit to the undertaking and the traders, and it is unfortunate that circumstances have prevented it being brought into effect.

DEATH FROM ELECTRIC SHOCK

An unfortunate accident occurred recently in Melbourne, when a woman died as the result of an electric shock received from the flexible connection of an iron she had been using. It appears that a wire broke at the iron plug and the woman attempted to effect repairs without first switching off the energy. Such an occurrence is doubly unfortunate in that it creates an impression of distrust of electricity in the minds of users and potential users of domestic electrical appliances. In reality the use of electricity in the home is quite safe if ordinary precautions are taken. Where shock does occur it is usually through carelessness, ignorance or misuse of the appliance. Practically the only way in which danger is likely to arise is through the user of electrical equipment allowing the connecting flexibles to become worn bare of insulation. It is quite easy, however, to observe and guard against this condition.

A feature of accidents such as this, which has been brought out by a correspondent in the press, is that although death is attributed directly to the electric shock it is more likely that the actual cause is fright or perhaps weakness of the heart. To the average person a shock at 200 volts from a house installation causes no ill effects whatever. It is therefore a pity that when an accident occurs such a feature is made of the electrical danger. Such publicity is quite unjustly detrimental to the best interests of the electrical industry, and puts in the minds of many individuals an unnecessary fear of a force which, properly controlled, is their very good servant.

The Editor and Staff wish all
readers

A Merry Christmas

and a

Prosperous New Year

Notes and Personals

Mr. J. H. Dewis, of AustralElectric Ltd., has accepted an appointment with Daniell, Whitehead and Co., Sydney.

Mr. G. Swinburne, a member of the Victorian electricity commission, returned recently by the s.s. Narkunda from a trip abroad.

Mr. Basil C. Caldwell, of the staff of Messrs. Gibson, Battle (Melb.) Pty. Ltd., has been appointed a director of the company.

The Shannon hydroelectric works in Ireland, being constructed by Siemens Schukert, have been declared black by the Irish trades union congress.

The city council of Wellington, N.Z., is satisfied with the operation of its fleet of motor buses which have given a severe check to private bus competition with the tramways.

Mr. W. H. Williams, electrical engineer to the Eaglehawk, Vic., borough council, has been appointed engineer of the new electric supply undertaking at Casino, N.S.W.

Mr. H. C. Van Valzah, Sydney manager of the Australian General Electric Co. Ltd., was married to Miss Olive Dalzell at St. Mark's church, Darling Point, Sydney, on December 3.

Mr. S. Y. Garnsworthy, manager in Launceston for Messrs. Oliver and Oliver, has been transferred to the staff of the Australian General Electric Co. Mr. J. L. Taylor will succeed Mr. Garnsworthy.

Mr. Robert Robertson, of the Scanlan Electric Co., who recently returned from America, is now attached to the staff of Amico Ltd., as consulting engineer to install a white way lighting system in Brisbane.

Mr. R. G. Crivelli, of the staff of the Victorian electricity commission, recently returned after a sojourn in Europe and resumed duty. He has been appointed superintendent of the north-eastern supply district, with headquarters at Benalla.

A recent press cable states that a 65,000 h.p. peat burning power station, located about 80 miles from Moscow, has been opened by M. Trotsky. The station is controlled by the Russian government. Russian, British and German firms supplied the equipment.

The chairman of the Brisbane tramway trust, which recently handed over its undertakings to the Greater Brisbane council, has expressed doubts as to whether the operation of motor buses in Brisbane will prove a financial success. The trust has invested in ten buses and the new controlling authority intends to watch the operation of these vehicles very carefully.

The Greater Brisbane council has accepted a tender for 250 Cosmos electric irons from Messrs. Trackson Bros. at 16/- each. The irons are to be supplied to consumers.

Mr. R. Alan Crook, who recently returned to Melbourne after a four years' tour abroad which he spent gaining experience in electrical engineering in Great Britain and the United States, has accepted a position as sales engineer with Metropolitan-Vickers (Australia) Pty. Ltd.

In an endeavor to meet road vehicle competition with railway passenger services the Victorian railway department is putting its own motor buses on certain country routes. An interurban service between Melbourne and Geelong, a distance of 45 miles has just been commenced.

At its meeting on Dec. 8 the Sydney city council adopted the recommendation of the electric supply committee that an intensive campaign of publicity, canvassing, etc., directly controlled and financed by the council, be initiated. Action to give effect to this decision is to be taken by the management of the electric supply department, by the preparation of details of the scheme, which are to be reported to the next council meeting.

A bill was recently before the Tasmanian legislature, providing for the setting up of a commission of three to control the hydroelectric department. The commission was to consist of the general manager of the department, as chairman, and two part-time commissioners. The bill was passed by the house of assembly, but turned down by the legislative council on the ground that the affairs of the department could safely be left in the hands of the general manager.

ELECTRICITY SUPPLY CONFERENCE

The annual conference of the Electricity Supply Association of Australia was held in Melbourne from Nov. 16 to 20 inclusive. Representatives of the principal electric supply authorities in all the states attended. At the various sittings matters affecting the welfare of the electric supply industry and of the consumers of electrical energy, were discussed. In addition, by courtesy of the local undertakings, visits of inspection were made to the Newport power houses and the Yarraville terminal station, the Yallourn works of the state electricity commission, and some of the substations of the Melbourne city council electric supply department. On the evening of November 19, members of the association and their ladies were entertained at dinner and a theatre party by the directors of the Melbourne Electric Supply Co.

The Fynn-Weichsel Motor*

For some time it has been recognised that the most effective element toward the solution of the power factor problem lies in a motor which has all the good characteristics of the present induction motor, and in addition the good characteristics of leading power factor or negative magnetising current of the synchronous motor. Such a machine, known as the Fynn-Weichsel motor, has recently been developed. It has a running performance better than that of a standard synchronous motor, starting performance as good as the best type of induction

supply circuit, so that the rotor winding is the primary of the motor. The stator is built up of laminated iron with slots all around the inside circumference, in exactly the same manner as in a standard polyphase induction motor. It carries two independent windings which are 90 electrical degrees displaced from each other. Electrically the stator winding is very similar to a standard two phase winding. Mechanically, however, it is considerably simpler, because it is of the so-called concentric type, which is the simplest winding known, while in standard motors the more complicated diamond winding is usually used.

Fig. 2 illustrates different ways of connecting the machine during starting. A shows the machine connected in the same manner as a standard slip-ring induction motor, i.e., during the starting period, resistance is connected across the two secondary windings. The value of the resistance is so selected as to give the machine the desired starting torque. By decreasing these resistances the machine obtains for a given required mechanical torque a higher speed, and finally when the resistances are short-circuited, the machine operates as a standard induction motor. If, at this time, the commuted winding of the rotor is connected in series with the winding F on the stator, the machine automatically increases its speed until it transforms itself into a synchronous machine.

This connection, while quite feasible, is desirable only for fairly large units. For medium and small sizes, it is possible to start the machine with the commutator winding permanently connected in series with the stator winding F. The connections are then as given in C. Resistances are connected in series with the F as well as with the A circuit. By decreasing the value of these resistances, the machine increases in speed until finally, when the resistances are short-circuited, the machine automatically transforms itself into a synchronous machine. This synchronisation takes place with a powerful torque and without excessive current draw from the line.

The physical phenomena which cause the easy synchronisation of this machine will be understood from the following:

If an induction motor runs fully loaded, the rotor operates with a speed slightly below the speed of the revolving field. This speed difference induces an e.m.f. of such a magnitude in the secondary winding as to produce a current just large enough to develop a torque — by interaction with the revolving field — which is equal and opposed to the mechanical useful

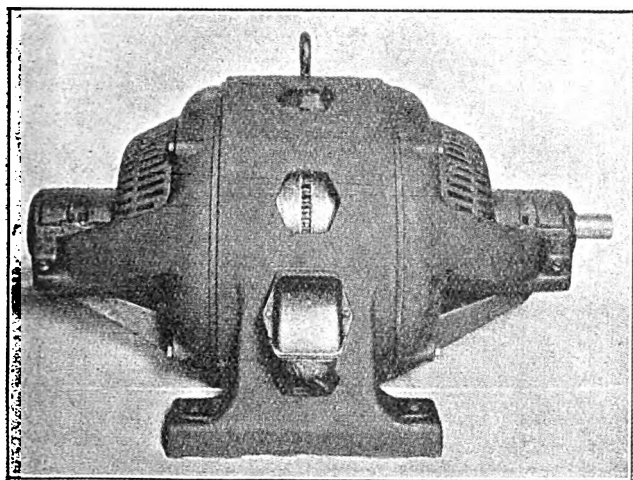


Fig. 1. 100 h.p. Fynn-Weichsel Motor

motor, and an admirable ability to synchronise automatically when going from starting to running operation. The general construction of the new machine does not differ materially from that used for many years in standard induction motors, and the appearance is very similar to that of an induction motor (vide Fig. 1). It has slip rings similar to those of a wound rotor motor, but in addition it has a small commutator. In large units the slip rings are at one end of the armature and the commutator at the other, but in the smaller motors both collecting devices are at the one end.

The rotor is built of laminated iron, with slots to take the windings. In the bottom of the slots is located a very small d.c. winding which is connected to the commutator. This winding generates a relatively low-voltage direct current for the excitation of the field when operating as a synchronous machine. The greater part of the slots is taken up by a winding which is connected to three slip rings. This winding is in every respect a standard polyphase winding. The slip rings are connected by brushes to the

*By Hans Weichsel, in Journal of the Franklin Institute.

torque which the motor has to overcome. If it is possible to increase the current in the secondary at this speed, then an excess of motor torque exists and results in speeding up the motor, because its torque is larger than the torque required for the useful load.

In order to accomplish this increase in current, it is simply necessary to have an e.m.f. acting on the secondary winding or windings which is larger than the e.m.f. induced in this winding due to the slip of the machine. Naturally this e.m.f. must have the same frequency and preferably the same phase relation as the e.m.f. induced by the slip of the machine. If, for instance, the slip of the motor is 5 per cent and the line frequency is 60 cycle, then the voltage induced in the secondary windings has the frequency 5 per cent $\times$ 60 = 3 cycle. Assuming that this voltage has a magnitude of five volts, and that in some manner there is injected into this circuit an additional two volts with a 3-cycle frequency, then a total voltage of seven volts is acting on the secondary circuit and the current increases in the relation of 7/5. Therefore, the slip of the machine approximately decreases in the ratio 5/7. By properly selecting the injected voltage, it is possible to decrease the slip of the motor when running as an induction machine to such a value that it will operate very nearly at synchronism and, therefore, can automatically synchronise.

The necessary injected low-frequency voltage is, in this new type of machine, generated in the simplest manner. The armature, as pointed out in the beginning, carries in addition to the main working a.c. winding a small commuted winding. The line voltage impressed on the slip rings produces a rotating magnetic field which revolves with a definite speed in respect to the armature conductors. In a 4-pole, 60 cycle machine, this speed would be 1,800 r.p.m. From the laws of induction, it is known that if this machine is allowed to operate as a motor, the armature must rotate in a direction opposite to that of the revolving field. Therefore, with increasing armature speed, the speed of the revolving field in respect to a fixed point in space will decrease, and when the armature rotates at synchronous speed the field revolving in respect to the armature conductors is stationary in respect to a fixed point in space.

There is, however, a fundamental law that the frequency of the voltage appearing across the brushes of a commuted winding is proportional to the relative speed of the field producing this voltage in respect to the brushes. If this speed is zero, the voltage across the brushes is of zero frequency, i.e., a d.c. voltage. If the field rotates against the brushes with a velocity corresponding to f_2 cycles, then the frequency across the brushes is f_2 . In other words, the frequency appearing across the brushes of this

new machine at any time is proportional to the frequency with which the field of the machine rotates in respect to the brushes; but this is the same frequency with which the field rotates in respect to the secondary windings. Therefore, the frequency of the voltage appearing across the commutator brushes is at any time equal to the frequency induced in the secondary winding.

A similar train of thought will lead to the conclusion that the voltage appearing across the commutator brushes is in phase with the voltage induced in the secondary when the brush axis coincides with the axis of this secondary winding. Therefore, if the commuted winding is connected in series with this secondary winding, the total voltage acting on this circuit is increased above the value which exists in this

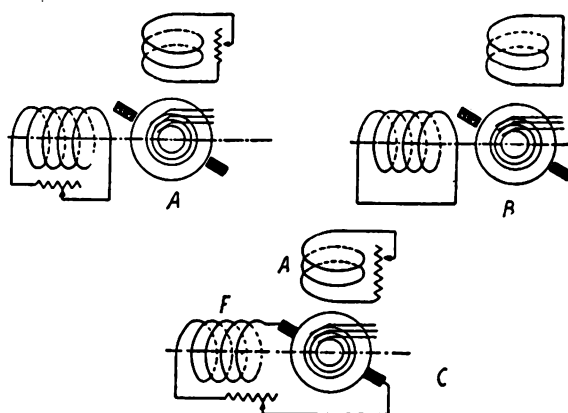


Fig. 2. Starting Connections

secondary winding due to the induction only. By properly selecting the magnitude of this injected voltage from the commutator, it is possible to increase the speed of the machine to such a value that it readily synchronises.

A further study of the voltage across the commutator shows that this voltage is of fixed magnitude, i.e., independent of the armature speed, because the velocity of the magnetic field in respect to the armature conductors is in no manner depending on the speed of the armature itself. It is a well-known fact, however, that the voltage induced in the secondary of an induction motor decreases with increasing speed.

Therefore, the ratio $\frac{\text{injected voltage}}{\text{induced voltage}}$ increases rapidly with increasing speed. The influence of the injected voltage on the speed of the machine is, therefore, self-accumulating, and becomes larger and larger the nearer the machine comes to synchronous speed.

This can be seen from the curves 1, 2, and 3, in Fig. 3, which show the speed torque curves of this type of machine when operating as a straight induction motor with different amounts of resistance in the secondary. The curves 4,

5, and 6 show the speed torque curves of the machine with the same resistance in the secondary circuit, but with an injected e.m.f. induced in the F winding by connecting this winding in series with the commuted winding. The shaded parts of these curves show the increase in the torque of the machine due to the injected e.m.f. for a given speed.

A further detailed study of the characteristics of this additional torque shows that it is of a pulsating nature and the pulsations become slower and slower as the machine approaches synchronous speed. This can readily be appreciated if it is remembered that this additional torque is produced by the injected low-frequency voltage. At the moment when this injected voltage is zero, it cannot produce any additional

polyphase induction motor, and the connections between starter and motor are in every respect identical with those for an ordinary motor.

As in any other synchronous motor, the total flux in the machine which finally must counter-balance the impressed voltage is practically constant in its magnitude, but its position in respect to the field winding depends on the load of the machine. Therefore, the direct current voltage appearing across the brushes of the commutator will to some extent vary with the load on the machine.

In any electric machine with a commutator, it is essential that the commutation be perfect. In this new type of machine, the relations are practically as perfect as in the best-known d.c. machine, because due to the co-operation of the d.c. and the a.c. armature windings, a neutralisation of the d.c. armature reaction takes place under any load condition. For any d.c. taken from the d.c. winding, a corresponding a.c. is taken from the line which completely neutralises the ampere turns of the d.c. winding. In other words, this machine has its d.c. armature reaction automatically neutralised at all loads, very similar to the conditions existing in neutralised d.c. machines and nearly identical to the condition existing in rotary converters.

In addition to this automatic neutralising effect, we have the favorable relation that in order to produce a certain d.c. voltage the number of turns on the armature can be kept relatively small because the velocity between the conductors and the field producing the d.c. e.m.f. is relatively high. This condition is contrary to that usually found in a.c. commutator motors, which as a rule have their secondary member on the rotor and, therefore, the number of armature turns must be high. For a given number of commutator segments, this would mean a relatively large number of turns between segments, thus making the leakage self-induction of these individual turns very high.

Fig. 4 shows a performance test on a standard 15 h.p. four-pole Fynn-Weichsel motor. It will be noticed that the efficiency increases rapidly with load and continues to increase even with loads beyond full load up to about 190 per cent normal load. At about this point, the efficiency curve has a drop and from here on decreases gradually, similar to an induction motor efficiency curve. At the point where the efficiency curve changes abruptly, the motor transforms itself from a synchronous to an asynchronous motor. From 190 per cent to 300 per cent load, the machine operates as an asynchronous motor, while between the loads from zero to 190 per cent it operates as a synchronous motor. The power factor is leading at no load and approaches

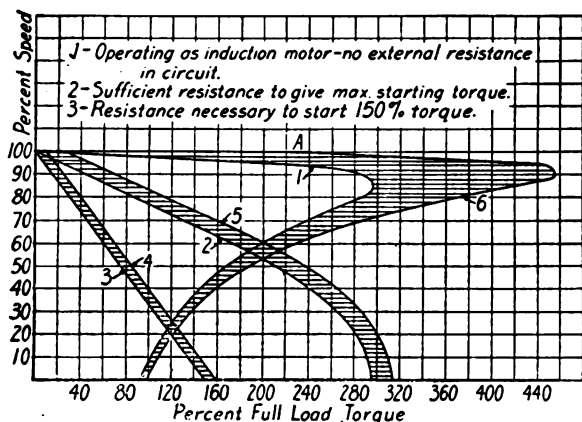


Fig. 3. Speed-Torque Curves

torque, and at the moment when the additional voltage has its maximum, the additional torque must be a maximum. Therefore, the torque will have as many maxima in a second as the injected current has during the same time.

The injected voltage is in phase with the induced voltage when the brush axis coincides with the field axis, which means that the best synchronising conditions are obtained when these two axes coincide. It has been found preferable, however, to have a relatively small angular displacement between the two axes, but a little study of the phenomena will show that a relatively small angular displacement between the brush axis and the axis of the secondary winding does not appreciably decrease the synchronising ability of the motor.

Machines, as regularly designed, are so dimensioned that they readily synchronise with a mechanical load of 150 to 200 per cent of their normal rating. Tests have shown that, when synchronising under 150 per cent load, there is no abnormal fluctuation of the line current, and that the secondary current undergoes a gradual transformation into direct current. The starting apparatus used is similar in general appearance to that for an ordinary slip-ring

unity with increasing load. In this particular case the machine has about 88 per cent leading power factor at full load and 60 per cent leading power factor at no load. Shortly before the motor ceases to operate as a synchronous motor and continues as an asynchronous motor the power factor is approximately unity. The corrective influence on line power factor of the leading wattless current of the Fynn-Weichsel motor is very marked. If a Fynn-Weichsel motor is operated in parallel with an ordinary induction motor of similar capacity, unity power factor is maintained on the line over practically the whole of the load range. In general it may be stated that if a number of squirrel cage motors are operated in parallel with a number of Fynn-Weichsel motors, and the ratio of the motors is properly selected, the power factor on the system may be kept at practically unity or any other desired value over nearly the whole load range of the installation.

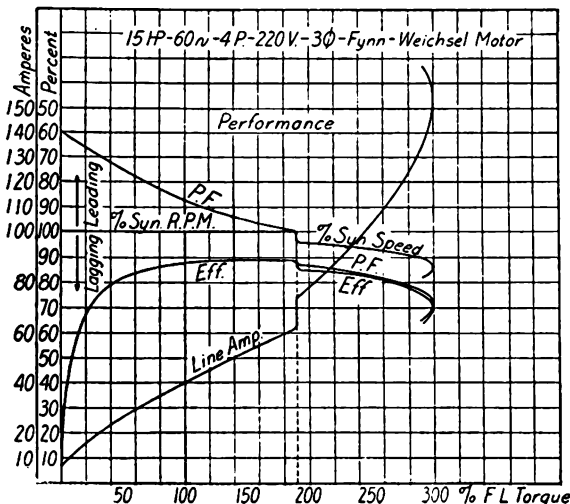


Fig. 4. Performance Curves of 15 h.p. Fynn-Weichsel Motor

The efficiency of a 15 h.p. unit is between 85 and 90 per cent, tending to rise with overloading up to the point of asynchronous operation, where there is a slight drop. In general the efficiency for large units is higher than for small, a relation which is exactly the same as that encountered in standard induction motors. Variation of voltage or frequency, up to as much as ± 10 or 5 per cent respectively, has practically no effect upon the efficiency up to about 150 per cent load. Beyond this load the question of maximum torque, which varies approximately as the square of the voltage enters into the matter. The effect of voltage variation, therefore, follows the same law as that which governs standard induction motors. The effect of voltage variation on the power factor is that, in general, the leading power factor approaches unity as the voltage increases. At fractional loads the change of power factor under this condition is quite rapid. This has a

stabilising effect on the line voltage, for if the line voltage tends to increase the power factor correcting effect due to the motor decreases, having thus a tendency to prevent the voltage from rising. On the other hand, if the voltage tends to decrease the correcting effect increases, thus tending to hold the voltage constant. As regards frequency variation the general effect is the opposite to that of voltage variation.

Besides the abnormal line conditions which have just been discussed, there may arise in practice abnormal conditions in the motor itself or in the wiring. For instance, one fuse in the three line wires leading to the machine might blow, leaving the motor to operate single phase. Under this condition it operates as a single phase synchronous motor, with an increase in line current for a given h.p. similar to that found in standard three phase induction motors when operated on single phase. If, for any reason, the circuit of the d.c. exciting winding is interrupted the motor operates as a polyphase motor with a single phase secondary. This results in a decreased output and poor power factor. Under this condition the line current pulsates in magnitude in the same manner as occurs in any polyphase induction motor running with single phase secondary. If, for emergency reasons, the commutator winding is cut out and the stator windings are short-circuited, the motor operates as a standard induction motor.

In practical application the Fynn-Weichsel motor has been found to give excellent service. One interesting installation that has been made is for driving a set of grinders. This service is very severe, as grinding wheels produce heavy peak loads. Whenever the load on the wheels is very heavy the motor pulls out of step and operates as an induction motor, but as soon as the peak ceases normal synchronous operation is resumed. Another installation is in a marble cutting and polishing factory. The peculiar characteristic of this industry is that the cutting and polishing must be done with absolutely constant speed. The synchronous speed of the Fynn-Weichsel motor is therefore very valuable in this application. Although there is a very considerable amount of inertia in the machinery no difficulty has been encountered in starting the motor and running it up to synchronous speed.

At present no limit is foreseen in the size of Fynn-Weichsel motors. A machine with such excellent characteristics, applicable over a wide range of powers should be a very important factor in the economy of industrial power developments. Detailed calculations have shown that an installation consisting of squirrel cage and Fynn-Weichsel motors is more efficient than an installation of similar power with induction motors and external apparatus for power factor correction.

Electricity in Water Supply and Sewerage Works, Sydney

By H. A. Stowe*

The city of Sydney has a population of 1,200,000, including the suburbs which come within the scope of the water supply herein described. The harbor has a total area of 22 square miles and habitable foreshores to the extent of 188 miles. The latter, being mostly low ground, necessitates a large amount of pumping in the disposal of the sewage, as nothing of this nature is allowed to drain into the harbor; it being carried by higher level sewers to ocean outfalls.

The nature of the country also is such that the complete supply of water by gravitation is not possible and therefore the reticulation is supplied from large tanks or reservoirs, placed

of motors driving auxiliaries and machine tools is approximately 8,216 h.p., which includes 3,500 h.p. used on the construction of a high pressure gravitation water tunnel.

Water Supply

The water supply is drawn from the Nepean river, and is augmented by the storage of water in the Cataract reservoir, which has a capacity of 21,400 million gal. From here the water is conveyed by a series of canals and tunnels over a distance of 40 miles to Prospect reservoir, which has a storage capacity of 11,029 million gal. This reservoir has only a small catchment area, so that it acts more or less as a balance reservoir.

From Prospect the water is conveyed four miles by canal to the pipe head where it is screened by passing through copper gauze screens with a mesh of 720 to the sq. in. The screens are continually being cleaned. They are handled by electrically operated cranes which lower dummy screens behind the gauze ones, thus shutting off the water in that section or bay. The water is then pumped out into one of the other bays by a portable electrically operated pump, and the screens are washed down with a hose. The process goes on day and night, there being altogether 400 screens, each 14 ft. x 3 ft., which are handled by two electrically operated cranes arranged for traveling and slewing. The cranes are driven by G.E. crane motors of $7\frac{1}{2}$ h.p. coupled to the main drive by laminated silent gears. Fig. 1 shows the screen bays and cranes.

From the pipe head the water is distributed to the various centres by a series of mains varying from 72 to 36 in. in diameter. At these centres pumping stations are located which pump the water to 44 elevated reservoirs or tanks for distribution.

For the supply for the suburbs on the north side of the harbor, the pumping station is situated at Ryde and is equipped at present with eight turbine driven pumps with prime movers totalling 8,200 h.p. The size of the pumps varies from 6 in. to 18 in. and they are capable of delivering a maximum total of 20 million gal. per day to an average head of 400 ft. Fig. 2 shows the new section of the Ryde pumping station containing the sets which pump to Chatswood and Pymble tanks. The units consist of 18 in. three stage centrifugal pumps running at 1,100 r.p.m., coupled to Willans and Robinson turbines of 1,100 and 1,500 b.h.p. capacity, running at 3,300 r.p.m., with steam at 160 lb. pressure.

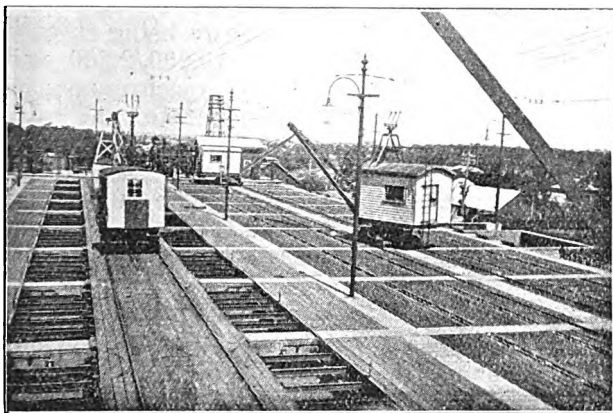


Fig. 1. Screening Chambers and Cranes, Pipe Head

at high points, which are filled by pumping. The whole of the water and sewerage undertaking is under the control of the Metropolitan Water, Sewerage and Drainage Board, and the capital expenditure to date is about £15,000,000. The average daily consumption of water at the present is 40,000,000 gal., but the consumption reaches as high as 80,000,000 gal. on hot days. Owing to the impossibility of using gravitation to any large extent 65 to 75 per cent of the water has to be pumped, and where the consumption is heavy large pumping units have had to be installed. The total power used for water pumping is 12,150 h.p., about 16 per cent of which is electrical.

The pumping of the sewage from the low levels to the gravitation or main sewers is done entirely electrically and the energy consumed amounts to approximately 2,620 h.p.; about 75 per cent of this is duplicated as a standby for emergency. The total electrical available h.p. in the board's service, inclusive

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The majority of the auxiliaries of this station are electrically driven, the power being supplied by duplicate 300 kw. turbo-alternators at 415 volts 50 cycle three phase. The units consist of Bruce Peebles alternators gear coupled to Parsons turbines running at 7,500 r.p.m. Each alternator has an extended bedplate to allow the stator to be moved clear of the rotor for overhaul and repair. These units also supply the lighting energy for the whole of the station. It is interesting to note that the old portion of this station contains two of the original James Watt vertical pumping engines of 240 h.p. which were installed about 1893. Their pumping capacity is about $1\frac{1}{4}$ million gal. per day.

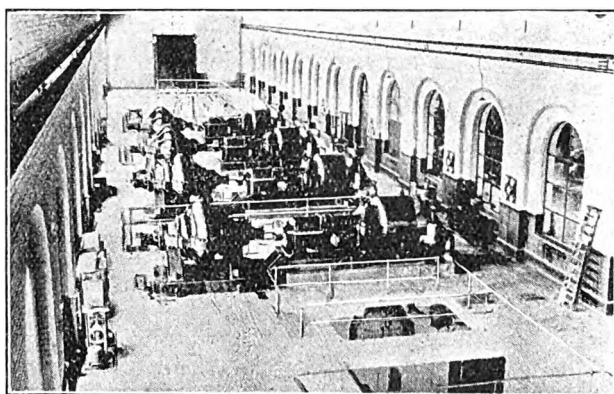


Fig. 2. New Section of Ryde Pumping Station

For the eastern suburbs the pumping station is situated at Crown street, city. This station is equipped with two Worthington steam pumps of 400 h.p. each and a capacity of 8,000 gal. per min. against 130 ft. head. There are also one turbine driven turbine pump, with capacity of 6,900 gal. per min., and one electrically driven pumping set consisting of a 700 h.p. 5,000 volt three phase motor direct coupled to two centrifugal pumps with capacity of 5,000 gal. per min. each, at an average head of 250 ft. The latter set runs at 750 r.p.m., only one pump being run at a time. A second similar set is being installed. The supply for this unit is taken from the Sydney municipal council's network. Installed here also are two 30 kv.a. and one 15 kv.a. three phase transformers stepping down to 415 volts for supplying power and light for the mechanical workshops, meter testing and repairing department, electrical workshops and blacksmiths.

This station is now assisted by the Waterloo pumping station, Fig. 3, which is entirely electrically operated. At Waterloo there are two 450 h.p., 5,000 volt three phase 1,500 r.p.m. G.E. synchronous induction motors coupled to two stage centrifugal pumps with capacity of 4,000 gal. per min. against 156 ft. head. The motors are arranged for automatic start with

push button control by G.E. high voltage type automatic starters. The motors start as squirrel cage induction motors but when up to speed the connections are changed so that the exciter comes into operation, and the machine then pulls into synchronism and runs as a synchronous motor. The motors are operated at unity power factor, a special rate for current being obtained by this means. The h.t. switch gear is arranged so that either of the two sets of incoming feeders can be coupled to either of the two sets of bus bars, thus giving complete change-over facilities in the event of breakdown on any part of the plant or system. The units so far installed represent one quarter of the plant intended to be erected in this station.

A similar station has been erected at Belmore to supply the southern districts, which are at present served by a small steam pumping station. The Belmore station is supplied by a 10,000 volt three phase feeder, the energy being stepped down by duplicate 390 kv.a., 10,000/2,200 volt transformers. There are two synchronous induction motors which will operate at unity power factor on 2,200 volts, direct coupled to centrifugal pumps of a capacity of 4,150 gal. per min. against 240 ft. head. The supply for this station, as in the case of the Waterloo station is taken from the Sydney municipal council's system.

In addition to these stations there are a number of smaller plants situated at various points to pump the water to high level tanks where the area is such that the supply becomes poor when the draw off from the main reservoir is heavy. These plants, six in number, are all electrically operated and are automatically controlled, being stopped and started by means of float switches. They therefore run unattended. The motors average about 15 h.p. and are all installed in duplicate. Some of these stations are operating on 600 volts d.c., where the a.c. mains are not available, the d.c. supply being taken from the tramway system.

In addition to the city and suburban supply the board controls the water supply to towns on the south coast some 40 miles from Sydney. These towns have an entirely independent supply. A rather unique system is in operation on this service. The towns are supplied from a small catchment area and reservoir at a considerable altitude. Below the reservoir there is a larger catchment area and reservoir which, although above the towns, is too low to gravitate its water over a range of mountains and so to the towns. Therefore a pump has been installed which is driven by a 50 h.p. 2,000 volt, three phase motor at 1,450 r.p.m. This pump lifts the water up to the higher reservoir, and the extra head carries it over the mountains to the towns. The energy for the motor driven pump

is supplied by a small hydroelectric plant which is located below the mountains just above the towns. The turbine is driven by the water feeding the town from the upper reservoir. The alternator is a 56 kw. 2,200 volt three phase Westinghouse machine running at 1,000 r.p.m. The turbine operates on a head of 550 ft. at a flow of 75 c. ft. per min. and develops 62.5 h.p.

The system is always left in operation, the turbine being controlled by a pressure governor which operates the valve according to the pressure of the main. This plant has now proved to be too small and it has been supplemented by a 100 h.p. 415 volt, three phase, 475 r.p.m. G.E. induction motor coupled to a four stage centrifugal pump and controlled by a G.E. contactor type automatic starter. The supply for this plant is taken from the Port Kembla power house situated on the coast $8\frac{1}{2}$ miles away. The supply is taken at 33,000 volts, three phase, and stepped down to 415 volts at the pump house.

For supplying the towns of Windsor and Richmond and the surrounding districts an electrically operated pumping plant has been installed on the bank of the Nepean river at Richmond, about four miles from the town. This consists of a 35 h.p. 2,200 volt three phase 60 cycle G.E. slip ring vertical type motor, running at 855 r.p.m., direct coupled to a four stage $3\frac{1}{2}$ in. centrifugal pump which is 60 ft. below the motor, the drive being through a $2\frac{1}{2}$ in. hollow steel shaft supported by ball bearings 7 ft. apart. The plant is automatically started by a G.E. high voltage contactor type automatic starter with push button control. There is a duplicate plant as a standby. The supply is taken from a 2,200 volt three phase 60 cycle feeder from the Hawkesbury agricultural college by means of five miles of aerial line. The pumps are capable of delivering 250 gal. per min. against 220 ft. head. As the water is drawn straight from the river bed and contains a certain amount of sand and weed, filters have been installed between the pumps and the reservoir.

A high pressure water tunnel is at present under construction to bring the water from the Potts Hill reservoir to the Waterloo pumping station. This tunnel is ten miles in length and is in a straight line. It will contain a concrete pipe 10 ft. in diameter and will have a capacity of 100 million gal. per day. In the construction of this tunnel 17 shafts have been sunk, some to a depth of 378 ft., and approximately 230 h.p. in electrical power is provided at each shaft, consisting mainly of two 80 h.p. 415 volt three phase motors belt connected to air compressors for supplying air for pneumatic tools and other uses. The rest of the power is absorbed in a hoist motor, fan motor, pump motors and for

lighting both above and below the ground. It is estimated that the tunnel will take approximately five years to complete.

Sewerage Works

In the low-lying districts where pumping is required the sewage is run into wells located at the pumping stations, from which it is raised to the high level gravitation outfall sewers. All of these pumping stations, 61 in number, are electrically equipped, the units ranging from $7\frac{1}{2}$ to 250 h.p. In all cases the plant is installed in duplicate and is automatically controlled by float switches acting in the wells. The stations

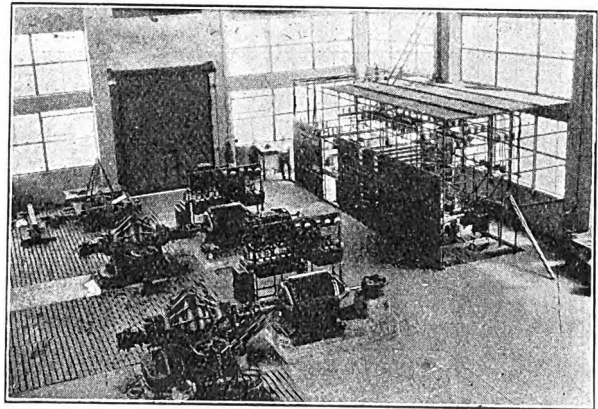


Fig. 3. Waterloo Water Supply Pumping Station

run unattended, being visited only once a day. Thirty-five of the stations are using 600 volt d.c. energy from the tramway system. The others are operating on 415 volt, three phase a.c. Fig. 4 shows a pumping unit at the Homebush station which is equipped with two 175 h.p. three phase, 415 volt G.E. motors, running at 500 r.p.m., each direct coupled to two 12-in. centrifugal pumps, one on each end of the shaft, capable of delivering 3,000 gal. per min. against a 55-ft. head. The motors are controlled by contactor type G.E. automatic starters operated by float switches in the intercepting wells.

The Mascot pumping station contains five units, two of 115 h.p., two of 30 h.p., and one of 250 h.p. The last consists of a G.E. induction motor direct coupled to two 14-in. centrifugal pumps capable of delivering 11,000 gal. per min. against 35-ft. head. It is controlled by a G.E. contactor type automatic starter and operated by a float switch.

In addition to the ocean outfall sewers several septic tank systems are in use, and on the north side of the harbor a system of activated sludge treatment of sewage is in operation in conjunction with the septic tank. In this plant the sewage is run into concrete tanks of 250,000 gal. capacity, eight in number, that have air pipes laid on the bottom. After the tanks have

been filled they are activated or aerated for eight hours by compressed air from small nozzles on the air pipes, at 15 lb. per sq. in. At the end of this time they are allowed to stand till the sediment settles on the bottom leaving the liquid fairly clear. This liquid is then drawn off by offtakes which float on the surface and do not in any way disturb the sludge or sediment. When the water is drawn off, the sludge is pumped into a septic tank and goes through the usual septic process.

The electrical equipment at this depot consists of two 200 h.p. 5,000 volt three phase 500 r.p.m. G.E. induction motors, each belt connected to Ingersoll Rand air compressors, which deliver 3,500 c. ft. of air per min. at 15 lb. per sq. in.

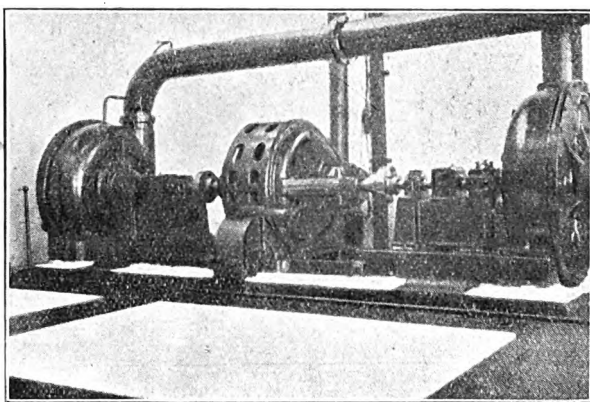


Fig. 4. 175 h.p. G.E. Motor, Direct Coupled to Pumps at Homebush Pumping Station.

when running at 155 r.p.m. In addition there are installed, for emergency service, two other units operating on 600 volts d.c. from the tramway supply. These consist of 80 h.p. d.c. motors, belt coupled to smaller Ingersoll Rand compressors.

At this depot there is a plant for making sodium hypochlorite for deodorising the septic tank effluent. A 50 h.p. 415 volt three phase squirrel cage G.E. motor, running at 950 r.p.m., drives a 50 kw. 100 volt d.c. generator. The d.c. energy is passed through cells having alternate positive and negative carbon electrodes over which sea water is flowing. The sea water passes over and under the electrodes and leaves the cells with a heavy content of chlorine which is run into the septic tank in sufficient quantities to neutralise all odor from same. The cells, eight in number, draw a load of approximately 120 amps from the generator.

In addition to the pumping of sewage from low lying districts, pumps have been installed to meet storm water conditions where the locality is such that the water may accumulate and cause a flood. Such a station is installed at Marrickville. This station is equipped with two horizontal steam pumping engines of 40 h.p. for sewage pumping, while for handling the

storm water there are four electrical units totalling 450 h.p. with total pumping capacity of 33,900 gal. per min., the head being only very low, approximately eight feet. The largest unit is of 180 h.p. operating on 415 volt three phase energy at 480 r.p.m., direct coupled to a two stage centrifugal pump having a capacity of 15,000 gal. per min. Each of the other three units are of 90 h.p. and are direct coupled to two stage pumps each with a capacity of 6,300 gal. per min. All these units are hand controlled by means of mining type ironclad switch pillars. This station is fed from the Sydney municipal council's system at 5,000 volts, a substation being installed within the pumping station.

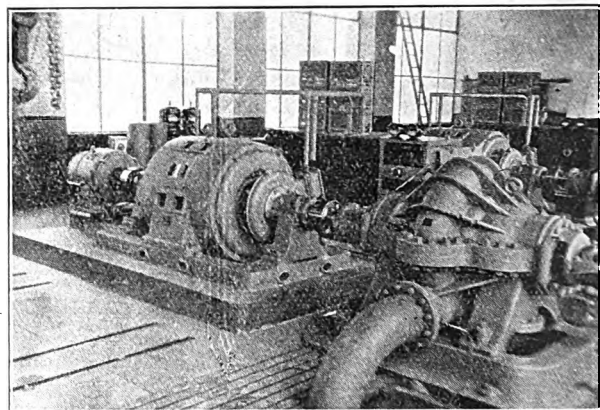


Fig. 5. 450 h.p., 2,200 volt Synchronous Induction Motors Driving Pumps at Lakemba Pumping Station.

In addition to electrically operated pumping units the board has installed a total of 400 h.p. in electric motors distributed at various depots and workshops, driving machine tools and special apparatus. Also, there are installed at three steam pumping stations small steam driven generators for supplying light and power for the station. The board has also in operation electrically operated apparatus for the purification of sewer gases in the large ventilating shafts. Three are operating on the chlorine spray principle, with a motor driven air compressor which forces a solution of chloride of lime through fine jets or sprays situated in the foot of the vent shaft, the vaporised chlorine acting as a deodoriser.

In addition to fixed plants electrically operated, over 100 h.p. is in use on temporary construction work for the operating of pumps, hoists and compressors, in the construction of new pumping stations and in water and sewerage trench work. Electricity is also used for a large number of special purposes, such as operating water level indicators and alarms. The supply in most of these cases is obtained from primary batteries, but in one instance it is given by a small motor generator operating on 415 volt, three phase a.c. energy and delivering 60 volt d.c.

New Oil-Electric Station at Woodside, S.A.

The Ambleside Milling and Lighting Co. Ltd. has recently inaugurated an undertaking to give electric supply to the small towns of Woodside, Ambleside, Balhannah, Charleston, Mt. Torrens, Oakbank, Springhead, and Tweedvale in the Onkaparinga district, South Australia. Primary distribution throughout the area is carried out at 11,000 volts, and secondary reticulation at 415/240 volts, 50 cycle three phase a.c. The power station is located on the bank of the Onkaparinga river at Woodside. From the station 11,000 volt energy passes by two three-core underground cables about 250 yd. in length to the centre of the town where connection is

is old. Experience has shown that the efficiency of this type of engine is but little impaired even after ten years or more of life, while the cost of upkeep is very light. The governor is of the double eccentric type and governs both the quantity of fuel and the timing of its injection in accordance with the load demands. No attention is required and the speed remains practically constant over all ranges of load. Normally the speed is 273 r.p.m. (synchronous speed), and for altering the speed when synchronising it is necessary to vary the tension of the governor springs, which is accomplished by means of a handwheel.

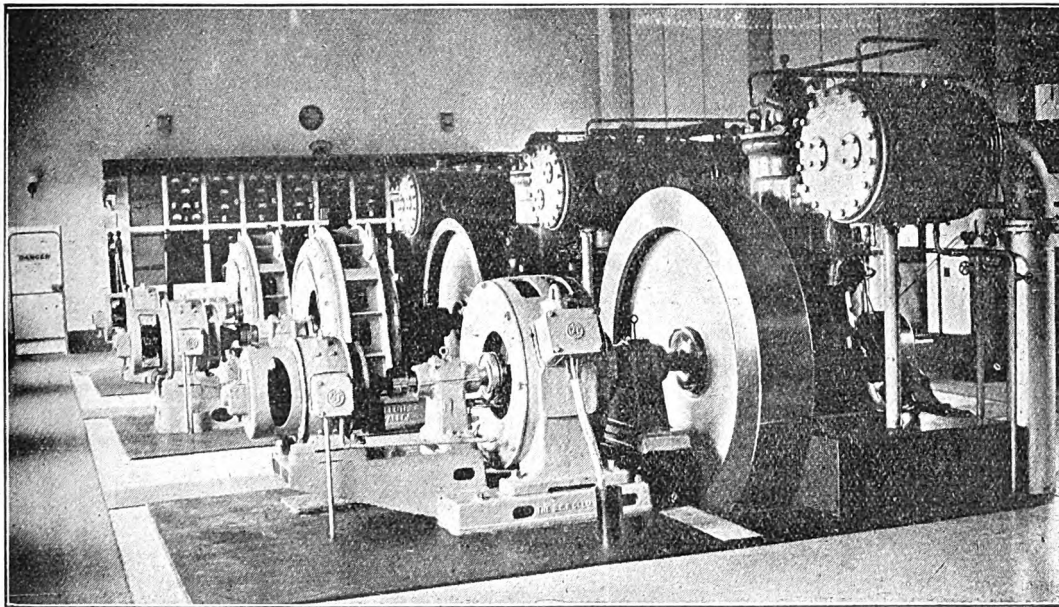


Fig. 1. Engine Room, Woodside Power Station

made to the overhead primary distribution lines. Near the point of connection is a step-down transformer giving supply to Woodside. The generating plant consists of three Vickers-Petters crude oil engines direct coupled to British Electric Plant Co. alternators. Two of the engines are of 240 h.p. capacity, four cylinder, and one is of 60 h.p., single cylinder. The alternator capacities are 180 and 45 kv.a. respectively, and the generating voltage is 415, 50 cycle three phase. The plant, which constitutes one of the largest crude oil installations in the Commonwealth, is shown in Fig. 1.

The engines are of the two cycle valveless type with crankcase compression of air and solid injection of fuel on to a hot cylinder head. The construction is such that no leakage occurs to the scavenging air even when the machine

There are four fuel pumps, one for each cylinder, the two upper pumps being for Nos. 1 and 2 cylinders and the lower for Nos. 3 and 4. Each pair of pumps is operated by a rocker arm operated in turn by a rod from the pump eccentric. Each pump injects the fuel into the cylinder head through an atomiser which converts the oil into a fine mist or spray. Lubrication is effected by a Madison Kipp mechanically driven lubricator which forces oil to four places in the cylinder wall, and separately to the large and small end connecting rod bearings, through a banjo ring in the former case and a vee block and hollow pin in the latter. The crankshaft main bearings are ring oiled from deep wells. The surplus oil from the crankcase is automatically ejected and after filtering may be used over again.

Starting is effected by compressed air previously stored in steel cylinders at a pressure of 150 lb. per sq. in. (the maximum engine compression pressure). There are three methods by which the air starting cylinders may be charged: (1) by the engine itself, (2) by hand, (3) by an auxiliary 3 h.p. engine belted to the compressor. The latter method is normally used at Woodside, the compressor engine being a Petter petrol kerosene machine of the two cycle type. Before actually starting the engines it is necessary to first heat up a small ignition tube on each vaporiser. This is

gases to a 5 ft. x 4 ft. reinforced concrete tunnel running the full length and outside of the power house, with manholes provided for cleaning purposes. At the river end of the building is a reinforced concrete stack which carries the gases well above the building. In order that gases from one engine will not return up the pipes to the other engines, should they be dismantled for repairs, each exhaust pipe is fitted with a butterfly valve.

Each engine is provided with its own circulating water pump direct driven by a Thrige electric motor. An arrangement of stopcocks

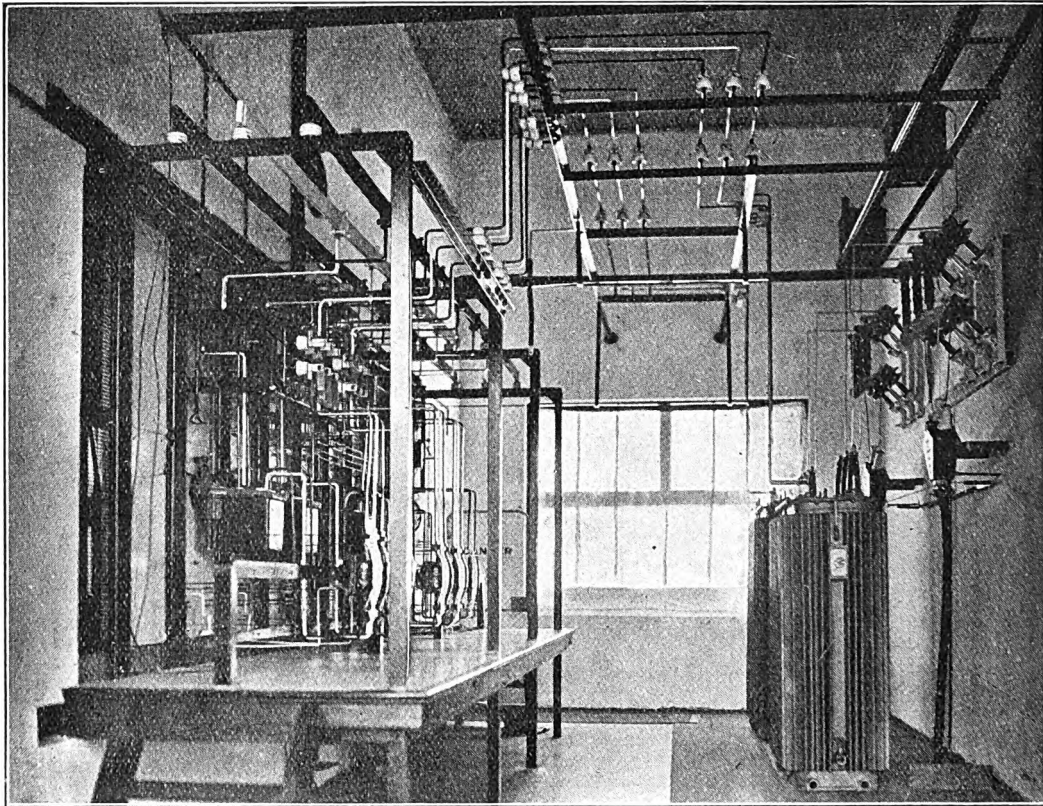


Fig. 2. Transformer Room, Woodside Power Station

effected by patent rapid safety lamps which require no preheating. These lamps are a permanent fixture on the engine and receive air and kerosene under air pressure derived from the starting air bottles. They burst into a hot blast immediately and the engines may be run up to full speed within $2\frac{1}{2}$ minutes of first lighting the lamps; in fact, it has been proved that two minutes is sufficient time even in unskilled hands. As soon as the engines reach full speed the lamps are extinguished and they are not required at all whilst the machines are running, even on light load.

Each engine exhausts into a marine type water cooled silencer attached to the engine cylinders. From these silencers pipes carry the

and cross connections enables any pump to be used on any engine. The motors are squirrel cage ball bearing, those on the 240 h.p. engine pumps being 3 h.p. 1,425 r.p.m., whilst that on the 60 h.p. pump is 2 h.p. 2,800 r.p.m. The water is pumped from a large underground storage tank filled from the river and, after passing through the engines, returns to the tank. Later it is proposed to erect a cooling tower. To provide for cases of emergency a 5 h.p. two cycle Petter petrol kerosene engine belt driving a centrifugal pump is erected in the workshop and interconnected with the cooling system, so that should the necessity arise this pump will serve to cool all three engines when operating under full load.

A large underground fuel storage tank has been built and as the power station is at a lower level than the Woodside railway station, some two hundred yards distant, a pipe line is provided to enable fuel oil, carried in tank cars from Port Adelaide, to gravitate direct to the station storage tank. No manual labor is required in handling fuel, all that is necessary being the connection of a hose between the tank car and the stand pipe in the station yard. From the underground storage tank a small centrifugal pump direct driven by a motor lifts the oil into each individual engine tank mounted on the wall to the left of the engines. The pump motor is controlled from the main switchboard and all oil passes through a meter for record purposes.

The generators are of the revolving field type, fitted with dampers and specially designed for parallel operation when driven by the engines to which they are coupled. They are single bearing machines with flange bolted direct to the engine half coupling, a heavy pedestal bearing being fitted between that half coupling and the engine flywheel. The 110 volt exciters are direct coupled through flexible couplings. Both alternator and exciter are mounted together on a heavy cast bedplate.

The selection of this generating plant demanded considerable care. Steam was out of the question for the undertaking as the cost would have been prohibitive, but the adoption of other prime movers made it necessary that particular attention be paid to the paralleling characteristics. The principal reasons leading to the selection of the present plant were the successful operation in parallel of two smaller similar sets at Burra, S.A., and the perfect parallel operation of a 240 h.p. Vickers-Petters engine and alternator with steam sets giving 100 cycle supply at Broken Hill, N.S.W. Other factors were the simplicity and low running cost of the engines and the fact that the parts of the single and four cylinder engines are interchangeable. It is satisfactory to note that the installation has complied with every condition of the contract with regard to parallel operation, alternator regulation, and consumption of fuel and lubricant. The fuel consumption was particularly good, being more than 10 per cent under the guarantee, whilst nothing better could be wished for in the matter of parallel running. It was anticipated that cross currents would be present with the single cylinder unit operating in parallel with the four cylinder units but even these were negligible. The ease with which the sets may be synchronised is remarkable, the machines remaining in step for quite long periods, so that there is no excuse for an attendant having trouble in this portion of his duties.

The electrical control of the plant is centralised in a 415 volt switchboard built in the wall at one end of the station building. At the rear of the board are two transformers for stepping up to the transmission pressure of 11,000 volts. The rear side of the board and the transformers are located in a special room quite apart from the engine room. By adopting this construction all live electrical equipment is segregated where there is no danger of accidental contact. In addition the shortest possible route is obtained for the leads from the oil switches and main busbars to the transformers. Fig. 2 shows the transformer room, with the rear of the switchboard on the left and the transformers on the right. The 11,000 volt leads from the transformers pass through isolating switches to the cable trifurcating boxes on the extreme right. The transformers were supplied by the E.M.F. Electric Co., of Melbourne.

The contractors for the generating plant were Messrs. Vickers-Petters Ltd., Melbourne, while the Southern Electric Power Co., Adelaide, was sub-contractor for the alternators and contractor for the complete pumping plant. The plant layout was executed by Mr. F. M. Houlton, chief engineer to the Ambleside Milling and Lighting Co.

BRISBANE TRAMWAYS

The Brisbane tramways, which have been under the administration of the tramway trust for the past three years, have been handed over to the Greater Brisbane council. The administration of the undertaking will still be carried out by the existing staff, but matters of policy will be decided by the transit committee of the council in place of the tramway trust.

ADELAIDE ELECTRIC SUPPLY

The Adelaide Electric Supply Co. is making arrangements to increase its capital in order to provide for necessary extensions. The operations of the company have been very successful, the net revenue for the last twelve months amounting to £307,088, or 9.87 per cent on the average amount of capital invested. The capital expenditure during the year totalled £449,778. For the current year there is an amount of £207,577 available, but this will not be sufficient to meet the capital requirements. In addition to rapidly increasing loading in the city and suburban areas, extensions to the supply are being carried for a considerable distance into the country districts. By the end of the current year there will be nearly 300 miles of country transmission lines in operation.

Automatic Telephony*

By J. H. Broome†

The first patents for automatic telephony were taken out in 1879, only three years after Bell invented the telephone, but the system put forward was not a commercial success. The first successful automatic system was patented by A. B. Strowger, of Kansas City, U.S.A., in 1889, and this was the forerunner of the present systems. The first automatic exchange was installed in 1892 at La Porte, Indiana. The system then in use required four wires between the subscriber's station and the exchange as well as a common return. Later developments brought about a reduction in the number of wires required, and further exchanges were opened, notably one of 1,000 lines capacity at Augusta, Georgia, in 1897, and one of 10,000 lines at New Bedford, Mass., in 1899. The first installation in Great Britain was made at Epsom in 1912, but since that date the British post office has adopted the automatic system almost universally and many large installations have been carried out. The first automatic exchange in Australia was that opened at Geelong, Vic., in 1912. There are now about 20 automatic exchanges in operation throughout the Commonwealth and many more are projected.

The automatic telephone has definitely established itself as a necessary adjunct to modern life, indeed it is only owing to the progress of automatic telephony that the problem of supplying efficient and rapid service to areas with very dense population is now possible of solution. Not the least difficulty associated with the manual system in a large city where there are a great number of exchanges is that of obtaining and training operators. In addition to personal qualifications the operator in a large system has a great deal to learn and remember, and as the system grows, manual working becomes more and more complicated. There are also special conditions under which automatic working is extremely valuable. For instance, in a cosmopolitan city, such as Cairo, the operators are required to speak several languages. The automatic, of course, solves the language difficulty at once, for practically all nationalities can recognise the figures on the dial.

The economic aspect of automatic telephony is, of course, very important. It may be taken as approximately correct to say that an automatic exchange equipment of a given capacity will cost twice as much as a manual equipment. This means that interest and depreciation charges are considerably higher for the former. Maintenance for automatic exchanges has been

proved to be only slightly higher than for manual. Rent, rates and taxes are approximately equal, with a tendency towards lower rent for automatic in consequence of the floor space requirements being less than with manual equipment. But the important factor is that with automatic equipment there are no operators' salaries to pay. This saving is such that the balance goes over heavily in favor of automatic, which further has the added advantage of giving 100 per cent service at all times during day or night. There is a further economic advantage in favor of automatic arising out of the instantaneous disconnect feature, which means that junctions between exchanges are only held during the actual manipulative and talking period. A considerable amount of time is saved by this, and fewer junctions are required for a given traffic load. The capital sunk in expensive line plant is thus considerably reduced. The saving of time in getting connection on the automatic system is also important. These advantages hold in all but the very small or special types of exchange. Trunk line working, in view of its special features must continue to be manually operated for some time.

PACIFIC CABLE BOARD

During the year ended Mar. 31 last the Pacific Cable Board handled international traffic totalling 11,900,000 words, and traffic between Australia and New Zealand and between these countries and the Pacific islands totalling 2,700,000 words. The receipts for the year amounted to £549,917, and the working expenditure to £265,328. Interest and repayment of capital to the British national debt commissioners absorbed £77,545, the reserve fund was augmented by £30,000, and interest and repayment on the loan for the New Zealand (1912) cable took £9,150. The surplus, £167,894, was devoted to the reserve and renewal fund. The operations for the year showed a decrease both in receipts and in expenditure, the former being due to reductions in rates and decline in ordinary traffic, and the latter to the fact that certain non-recurring outlay was necessary during the previous year. During the year contracts were placed with the Telegraph Construction and Maintenance Co. and Messrs. Siemens Bros. and Co. Ltd. for the construction and laying of new cable sections between Bamfield, Vancouver, and Fanning Island and between the latter place and Suva, Fiji, respectively.

*Extract from paper read before Institution of Engineers (Aust.). Brisbane Division.

†Siemens Bros. and Co. Ltd., London.

Mercury Arc Rectifiers on Melbourne Suburban Railways

The recent extension of the electrified services of the Victorian railways to Fern Tree Gully and Lilydale entailed the provision of two automatic substations at Lower Fern Tree Gully and Mooroolbark respectively. The railway commissioners, when considering the equipment of the substations, decided to install mercury arc

rating of 900 kw. with a two-hour overload of 50 per cent or 1,350 kw., and a half minute capacity of 3,000 kw.

The substation buildings are of simple and economical construction, the walls being of 9-in. brickwork and the roofs of corrugated iron ceiled with fibro-cement. The floors are of con-

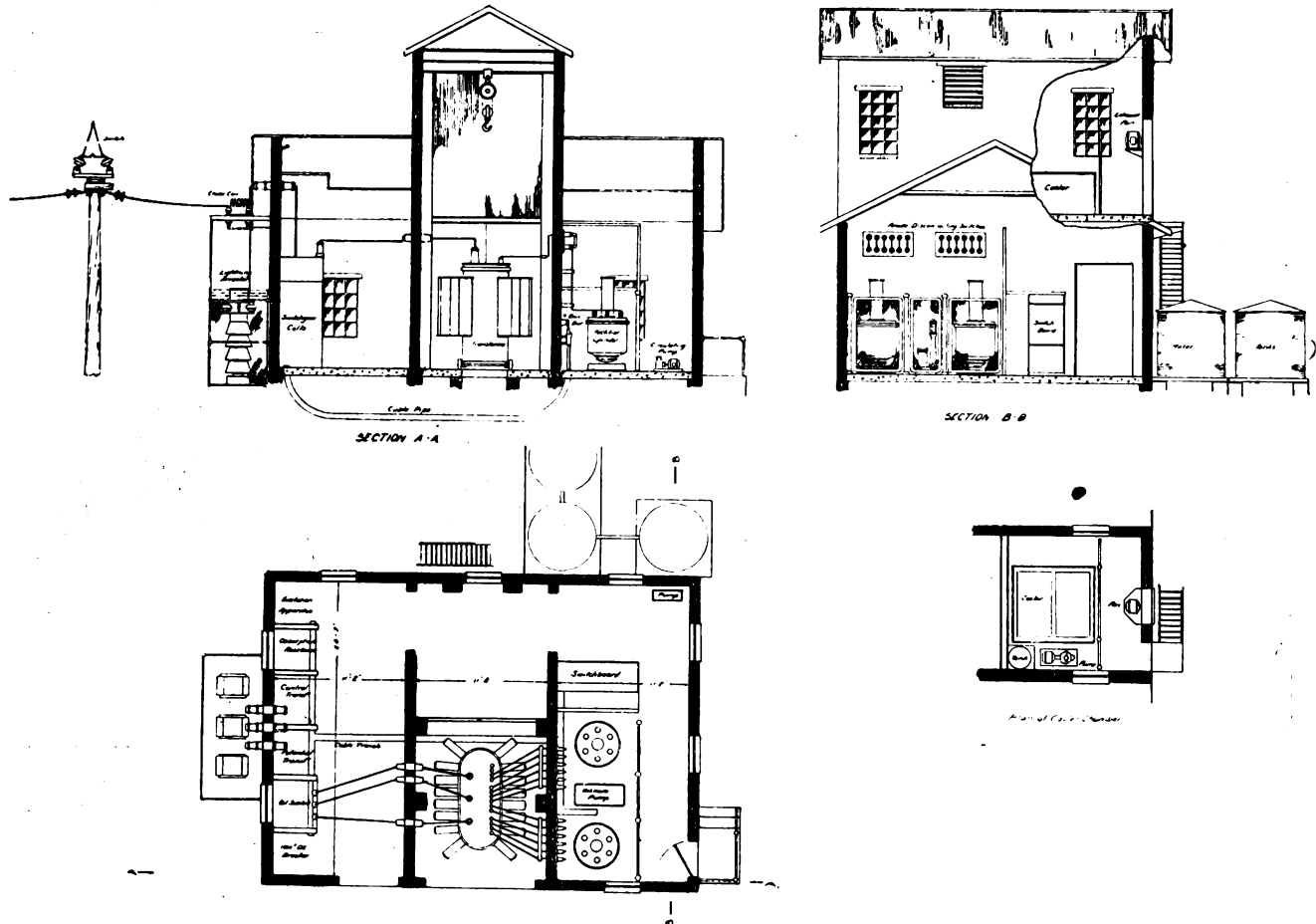


Fig. 1. General Arrangement of Plant in Rectifier Substations, Victorian Railways

rectifiers with a view to determining their suitability for this class of service. Accordingly, in January last an order was placed with Messrs. Gibson, Battle (Melb.) Pty. Ltd. for two substation equipments fitted for completely automatic operation. These were manufactured by Brown, Boveri Ltd., in Switzerland, and were delivered in August. Each equipment consists of a step down transformer of special design which supplies current to two rectifier cylinders in parallel, together with the necessary vacuum pump, switch gear and auxiliary devices for automatic operation. Each set has a continuous

crete. The dimensions are 35 ft. by 24 ft. 6 in. inside measurement, by 15 ft. 6 in. high, except in the central portion which has a height of 26 ft. 9 in. Each building is divided by brick partition walls into three chambers. The front of the central portion contains the main transformer the extra height allowing the core to be lifted from the tank. The rear upper portion of the central part forms a chamber in which are installed the water circulating pump, radiator and exhaust fan. Access to this chamber is by an external stair. The rectifier cylinders are water cooled and the cooling water is

circulated through the radiator. The fan is used to draw air from the interior of the station over the radiator and discharge it through a louvred ventilator. It is required only in summer.

The high tension power supply is at 20 kv., 25 cycles three phase, and is transmitted by overhead lines which terminate on a pole just outside the substation. On the top of this pole is an air-break switch from which the conductors run to choke coils mounted on a steel framework

circuit breaker are closed by single phase series motors. The control transformer supplies power for these motors and for the circulating pumps, fan and vacuum pump. It likewise maintains the ignition and excitation arcs of the rectifiers, operates the various relays and lights the substation and the adjacent railway station.

The main transformer has a star wound primary and two separate double-star secondaries with the neutrals brought out. There are thus 14 terminals on the low tension side. Each rectifier cylinder has six main anodes to each

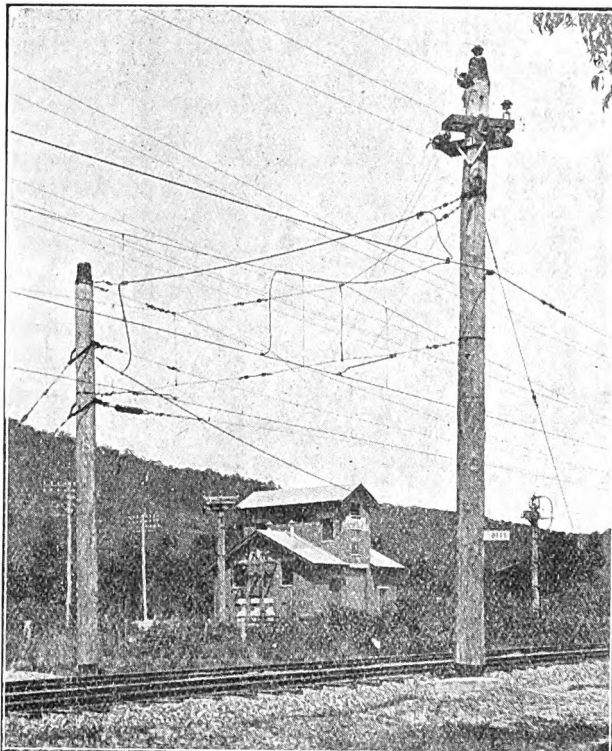


Fig. 2. Lower Ferntree Gully Substation, Showing Incoming H.T. Line, D.C. Feeders and Catenary Suspension on Track.

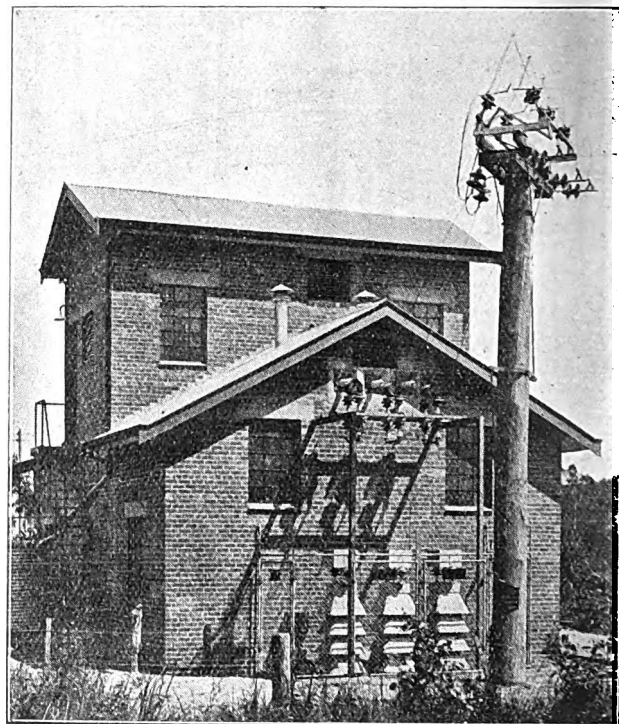


Fig. 3. Lower Ferntree Gully Substation, Showing Incoming Line, Air Break Switches, Choke Coils and Lightning Arresters.

attached to the wall of the building. Below the choke coils are disconnecting switches, and outdoor lightning arresters are mounted on the ground beneath. Porcelain wall bushings carry the conductors through the wall of the station. The air-break switches, choke coils and isolating switches for both stations were manufactured by Metropolitan-Vickers (Aust.) Ltd., Melbourne. The lightning arresters at Lower Ferntree Gully are of the oxide film type, manufactured by the General Electric Co., U.S.A., while those at Mooroolbark are of the autovalve type, manufactured by the Westinghouse Co., U.S.A.

The left-hand bay of the building contains the 20 kv. oil switch, the d.c. circuit breaker, the control transformer, the reactance coil and the excitation transformers. Here also are the potential and current transformers used for metering. The oil switch and 1,500 volt d.c.

oil of which one lead from the transformer is connected. The cathodes of both cylinders are connected to the positive busbar, and the two neutrals of the transformer secondaries are connected to the track rails through the reactance coil.

The sequence of operation, which is completely automatic, is as follows:—

On a train approaching the substation the voltage of the contact wire decreases and an undervoltage relay closes its contacts. After a short time delay, interposed to prevent false starts due to rapid voltage fluctuations, the main oil switch is closed. This causes the main and auxiliary anodes of the rectifier to be excited and the ignition electrode to be drawn down into contact with the cathode mercury at the bottom of the cylinder and then withdrawn. The withdrawal gives rise to an arc at the

surface of the cathode which ionises the atmosphere within the rectifier. The auxiliary anodes

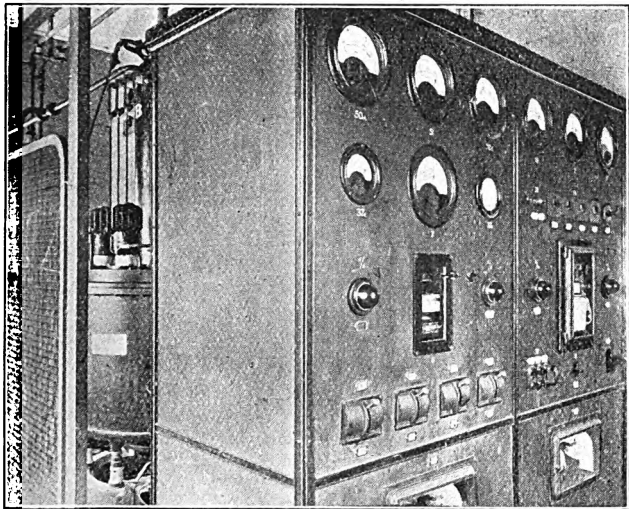


Fig. 4. Switchboard, with one Rectifier Cylinder Showing at Rear on Left.

immediately commence arcing to the cathode, their circuit being completed through an external

resistance. This arc continues the whole time the rectifier is in service and keeps the interior ionised. The current carried by the auxiliary arc is from three to four amps, As soon as it commences to flow it operates a relay which completes the closing circuit of the d.c. circuit breaker. This closes, connecting the cathode to the load, and the main anodes commence to arc. In practice the closing of the circuit breaker takes place two or three seconds after that of the oil switch.

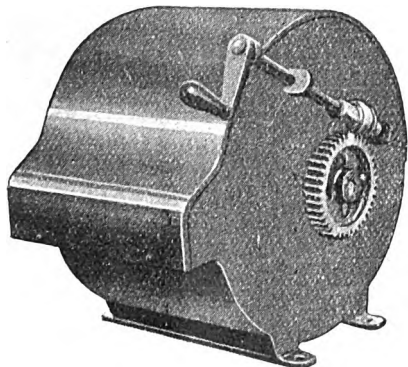
The special pump which is used to maintain the vacuum in the rectifier is also switched on and off automatically in an ingenious manner. A Wheatstone bridge of platinum wires sealed into a glass bulb is employed. Variations in the density of the atmosphere surrounding the wires cause the pointer of a contact-making galvanometer to deflect and operate a relay. The glass bulb is connected to the interior of the rectifier and variations in vacuum cause the pump to be switched on and off as required.

The installation of this plant was carried out by the staff of the chief electrical engineer's branch, Victorian railways, in conjunction with an engineer from the manufacturer's works.

Switchgear Manufacture

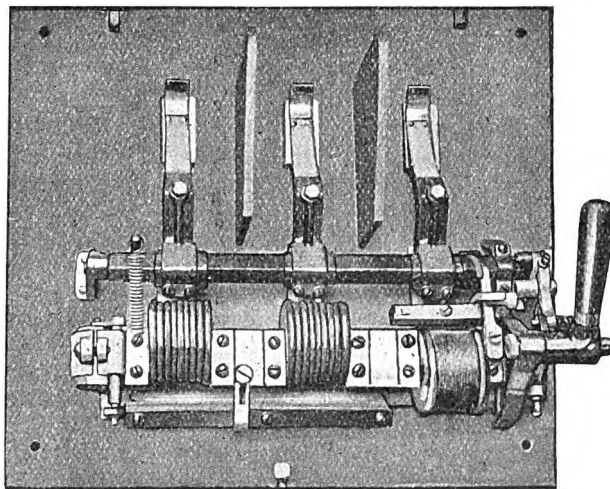
During the last few years a considerable advance has been made in the manufacture of electrical plant and machinery in Australia. A number of overseas firms have established works in different states, while local undertakings have commenced operations, in many cases with

together as apprentices in a Melbourne electrical workshop. Later, with a backing of experience gained in wider fields, they founded the present



W. and B. Liquid Rotor Starter

marked success. A typical example of a successful manufacturing concern built up on local enterprise and capital is the establishment of Messrs. Williams and Benwell. This firm specialises in the manufacture of switchgear for mill work and factories. The partners, at the outset of their engineering career, worked



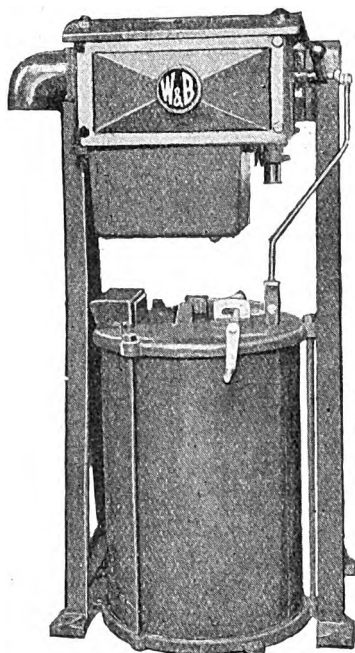
W. and B. Air Break Circuit Breaker

establishment which, by steady industry, they have built up to be a thoroughly sound concern.

The present factory and offices are combined in a brick building in South Melbourne, where

a considerable staff of skilled tradesmen is employed. All the designing and a great deal of the supervisory work is carried out by the partners themselves and thus overhead charges are kept at an extraordinarily low level. The administrative system is the simplest possible and the policy of the firm may be summed up in the statement that "It is better to lose four shillings than set about trying to save it, only to discover that five shillings is spent in the process."

The products of the establishment cover a range including no-volt switches, air-break and oil circuit breakers, motor starters (including star-delta switches, auto-transformer starters,

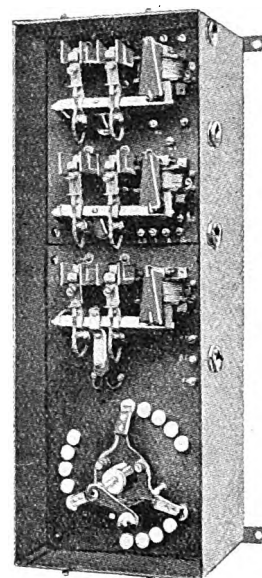


W. and B. Oil Immersed Circuit Breaker
Mechanically Interlocked with Rotor Starter

and rotor starters of both the wire and liquid resistance type), and automatic starting and control panels of every description. The various lines are made up either for stock or as special contract work. After several years of experimenting and practical experience, designs have been arrived at which provide sound, substantial equipment well able to stand up to the demands of service.

A second feature largely responsible for the low cost of manufacture is the standardisation of parts so that many portions of different switches are interchangeable. For instance, the same no-volt coil is used in all equipment, with just the slight difference in winding necessary for different supply systems. The coil frames and armatures for the overload coils are also standardised. The same type of contact is used in many switches. By this means advantage can be taken of mass production methods in keeping down costs.

The layout of the shop and the method of working also tend to reduce costs. Each bench is set apart for a particular operation with the proper tools within easy reach. The greatest possible use is made of jigs and dies, and presses and turret lathes are extensively used in the manufacture of parts. The various switches



W. and B. A.C. Controller

are designed not only with a view to maximum interchangeability of parts, but in such a manner that the processes of manufacture are simple.

The best evidence of the success of the firm's policy and the reliability of its products is given by the steady expansion of the business. This is reflected in the increasing space requirements. The present building was erected to provide relief from cramped quarters, and although it is only about two years since it was erected, it is anticipated that further extensions will shortly be necessary.

TIDAL POWER SCHEME

A proposal is on foot for developing electrical energy from the rise and fall of the tides in the bay of Fundy, for the benefit of the state of Maine, U.S.A., and the provinces of New Brunswick and Nova Scotia, Canada. The difference between high and low tide in this inlet is probably greater than in any other part of the world. It is proposed to wall off two portions of the bay and to utilise the admission and discharge of water to and from the pools so formed to develop hydroelectric power. It is estimated that a maximum of 700,000 h.p. can be developed at a cost between £15,000,000 and £20,000,000.

Victorian Electricity Commission

The sixth annual report of the state electricity commission of Victoria, covering operations during the year ended June 30, 1925, contains a great deal of information descriptive of the commission's various undertakings. The activities of the commission may be divided under five principal headings:—The open cut mining and supply of brown coal, the manufacture and distribution of briquettes, the generation and bulk supply of electrical energy, the retailing of electrical energy in numerous centres, and the general supervision of electrical matters throughout the state.

The report gives an interesting description of the operations involved in coal winning from the open cuts at Yallourn. During the period under review the output of the new open cut, where the coal winning and handling is carried out by mechanical means, was 442,560 tons. The whole of this quantity passed through the screening house for distribution to the briquetting factory and to the power station. The output of the old open cut, where the coal excavating is performed by hand, was 170,966 tons. The profit and loss account for the old open cut shows revenues amounting to £92,684 from sales of coal and £475 from rents, making a total revenue of £93,159. Against this are the amounts of £55,906 for operating and maintenance expenses, £1,216 for selling expenses, £34,898 for freight and £1,139 for interest, making a total expenditure of £93,159. No similar financial statement is given in regard to the new open cut. According to the balance sheet, however, the value of the coal supply plant and equipment is put down at £693,604.

The briquetting factory commenced operations in February, 1925. Up to the end of the financial year the factory had turned out 36,500 tons of briquettes, this being at the rate of about 9,000 tons per month. The profit and loss account shows that the revenue from sale of briquettes during the period totalled £47,059. Added to this is the value of the briquettes in stock at June 30, £675, making a total of £47,734. On the expenditure side are shown operating and maintenance expenses £68,154, freight £35, selling expenses £997, and interest £14,805, making a total of £83,991. The loss on operations since the plant commenced running is, therefore, £36,257. The capital value of the plant is set down at £493,146. The commission states that, during last winter the demand for household briquettes was greater than the capacity of the plant. It is recommending to the government that the plant be extended to treble the present capacity, so as to raise the output to 330,000

tons per annum. It claims that with the increased capacity the cost of production will be considerably reduced. At the present plant there are five presses; it is proposed to install 11 more presses, with their associated crushing, drying and steam-raising machinery, at an estimated cost of £630,000. It will take approximately three years, from the time of obtaining approval of the proposal, to install the additional plant.

The first units at the main electricity generating station, Yallourn, came into operation just before the commencement of the financial year. During the year the load has been growing steadily but the output of the station is still considerably below its rated capacity. No figures of the operation of the station are given in the report, but from an appended chart it appears that the output of energy for the twelve months was about 68,600,000 units. During this period the coal consumption was 263,800 tons, made up of 187,235 tons from the new open cut and 76,565 tons from the old cut. The new cut coal has a considerably higher moisture content than that from the old cut. The two grades were burnt under separate boilers.

No separate details are given of the operations of the Newport B power station. From the abovementioned chart it appears that the output was about 49,900,000 units for the year. This station is run as a peak load supply, the Yallourn station taking the higher load factor portion of the demand. In the metropolitan supply system, which is served by these two stations, and for which also bulk energy is purchased from the 25 cycle Newport A station of the railway commissioners, 101,000,000 units of energy were sold during the year at an average price of .665d. per unit. The total revenue on the operations of the system was £493,110. Against this are set the following costs:—Power generation £310,281, purchase of energy £211,112, transmission, transformation and distribution £31,791, interest £170,438, depreciation £18,476, debit balance from June 30, 1924, £54,475. Thus there is an accumulated loss of £303,463 on the operations to the end of the financial year. It must be remembered, however, that the scheme is capable of supplying 320,000,000 units per annum, and that it is, therefore, working considerably below its capacity. It is anticipated that, in about three years, when the system is fully loaded, the operations will show a credit balance.

In the metropolitan area the commission gives bulk energy supplies to the Melbourne Electric Supply Co., the city councils of Melbourne,

Brunswick, Footscray, Williamstown and Coburg, the shire of Nunawading and H. V. McKay Pty. Ltd., Sunshine, all of which are retail supply authorities. Since the end of the financial year the municipalities of Northcote, Preston, and Heidelberg also have commenced taking supply from the commission. In addition supplies are given to several large industrial concerns and the commission has control of retail supply in the Essendon-Flemington area and in certain of the outer suburban districts. Some of the large industrial consumers are supplied with 25 cycle energy purchased from the railway commissioners. During the year the government entered into an agreement with the Melbourne Electric Supply Co. under which the electricity commission is given supervisory control of the company's undertaking until the expiration of the company's franchise. The commission and the company are undertaking in conjunction the important work of changing over the supply in the industrial portions of the area from single phase to three phase. The commission is installing substations, fed by a ring main from the Yarraville terminal station, at convenient points for supplying the company with bulk energy. The first of these stations, with a capacity of 18,000 kv.a. has been erected in Collingwood. This station is connected to substation J, which supplies the Melbourne city council, by two 0.15 sq. in. underground cables. Other substations of smaller capacity have been erected during the year, notably those at Preston and Sunshine.

The Essendon-Flemington retail supply district is served with energy from a substation at Ascot Vale. During the year the sales of energy totalled 7,439,135 units, the number of consumers being 9,897. The maximum demand was 2,462 kw. The revenue from energy sales totalled £79,730. Operating costs, interest, depreciation, etc., totalled £75,730, thus a profit of £4,000 was realised on the year's operations.

The eastern metropolitan area is supplied by a 22,000 volt overhead line running, along the route of the main Yallourn transmission line, from Thomastown to Dandenong. A 6,000 kv.a. substation at Ringwood serves the borough of Ringwood and the shire of Lilydale. There are 2,246 consumers on the system, and the units sold totalled 429,129, with a maximum demand of 300 kw. The revenue totalled £10,057 and the expenditure £7,438, leaving a profit of £2,619.

For the south-western metropolitan district, including the towns of Werribee and Altona, the units sold totalled 617,318. The number of consumers is 497 and the maximum demand 131 kw. The total revenue amounted to £5,691, and the expenditure to £5,356, giving a profit of £335.

In addition to giving supply in the above-mentioned areas the commission has large country district schemes, supplying energy to numerous country towns, to rural industries and to farming communities. The largest of these schemes at present is that in the south-western district. Energy for this supply is purchased from the Melbourne Electric Supply Co. at Geelong, and transmitted over a 44,000 volt line 116 miles in length to Warrnambool. This line gives supply to several towns en route, and from it 6,600 volt branch lines radiate to numerous other loading centres. The aggregate length of lines at the lower pressure is 123 miles. At present 20 towns and townships and 10 rural groups are receiving supplies. The low tension distribution is carried out at 400/230 volts three phase and 230 volts single phase, 50 cycle a.c., and there is an aggregate of 103 miles of reticulation lines.

During the last twelve months nine small towns and four rural centres received supply for the first time, 49 miles of 6,600 volt lines and 29 miles of low tension lines being put into operation. In all 1,144 new consumers were connected during the year; this brings the total number up to 3,683. During the year the units sold totalled 1,283,983, with a maximum demand of 732 kw. The revenue totalled £36,170 and the expenditure £44,405. The latter amount included £4,462 debit balance from the previous year, making an accumulated loss of £8,235. In addition to supplies for lighting and for domestic and farming power purposes, energy is made available to the numerous butter and milk product factories throughout the district. It is expected that it will not be long before practically every butter factory within reach of the commission's mains will be taking supply. It is considered that with further building up of the load the system will become self-supporting.

In the Gippsland district scheme, supplied from Yallourn, 996,735 units were sold during the year. The number of consumers was 2,881 and the maximum demand 532 kw. The revenue for the year was £22,586 and a credit balance of £129 was brought forward from the previous year. The expenditure totalled £21,275, leaving a profit of £1,440. In the north-eastern district a main transmission line is in course of construction from the Thomastown substation, near Melbourne, with branches serving the various towns. At first Yallourn energy will be used in this service, but later supplies will be derived from the Sugarloaf-Rubicon hydroelectric scheme, on which construction work is about to be commenced. At present two local undertakings, those at Shepparton and Echuca, have been taken over by the commission and are being operated pending the completion of the trans-

mission system. The operation of these undertakings during the year resulted in a profit of £1,352.

There are now 53 towns receiving retail electrical service from the commission. Of these 23 were connected during the year under review. The most important rural industries served are the butter and milk product factories, of which there are now 22 connected. On June 1, 1925, the commission introduced a two-part tariff for retail electricity supply. It is designed with a view to encouraging the use of electricity for domestic services, and is made up of a service charge based on the number of rooms in the dwelling and an energy charge for the number of units used. In the report, however, the commission states that the full advantage of this tariff is not always available, as consumers are deterred by the high first cost of domestic electrical apparatus from using large amounts of energy.

In its various transmission systems the commission now operates 110 route miles of 132 kv. lines, 116 miles of 44 kv. lines, 198 miles of 22 kv. lines and 178 miles of 6.6 kv. lines. In addition, there are 49 miles of 22 kv. underground cable in the metropolitan area. The total installed capacity of the commission's sub-stations is 132,635 kv.a., of which 60,000 kv.a. is at the Yarraville terminal station.

Amongst other activities of the commission during the year were the completion of an additional 112 houses in the town of Yallourn, the installation at Yarraville terminal station of a 5,000 kw. frequency changer purchased from the Melbourne city council, and the carrying out, in conjunction with the railway department, of certain experiments on pulverised coal. At the commission's pulverising plant at Newport

9,372 tons of brown coal and 2,274 tons of black coal were treated. For research on the low temperature carbonisation of brown coal a pilot carbonising plant has been erected at Yallourn.

A commencement is about to be made on the Sugarloaf-Rubicon hydroelectric scheme in order to cope with the rapidly-increasing load demands of the state. The scheme involves the laying down of an 18,000 h.p. hydroelectric plant to be driven by the discharge from the Sugarloaf irrigation reservoir, with subsidiary plants on adjacent streams to supplement the supply when the reservoir discharge is not available. The system of stations will be capable of supplying a maximum demand of 25,000 kw., and of giving an annual output of 137,000,000 units. The cost of the hydraulic works is estimated at £526,680 and that of the electrical portion other than the main transmission line, at £277,000.

The capital cost of the commission's works to date is £7,246,768, to which is added £514,642, representing interest during the construction period. The commission is asking to be relieved of the latter charge. By the time the present construction works are completed the interest on the capitalised interest during construction will amount to £43,000 per annum. During the year the commission's activities were partly held up owing to instructions from the government to curtail loan expenditure. Amongst the works thus delayed were the completion of the Yallourn power station, the construction of Yallourn township, the removal of overburden at the open cut, the commencement of the Sugarloaf-Rubicon hydroelectric scheme, and the extension of the country district supplies. One direct result of this delay is that the commission anticipates difficulty in supplying the electrical demands of the metropolitan area during the winter of 1927.

REGISTRATION OF WIREMEN IN NEW ZEALAND

The New Zealand parliament has passed an act to provide for the registration of electrical wiremen and for the regulation of electrical wiring work. Under its provisions electrical wiring work may only be carried out by a registered electrical wireman, with or without the assistance of apprentices. Registration may be obtained on presentation of suitable qualifications, or on passing a prescribed examination. The act will be administered by a registration board consisting of the chief electrical engineer of the public works department, and one representative each from the electric supply undertakings, the fire insurance companies, the electrical traders or contractors and the electrical wiremen.

NEW INCANDESCENT LAMP

The Westinghouse Co. of America has recently introduced a new form of incandescent lamp with the bowl frosted on the inside. It is claimed that this finish eliminates glare, furnishing a soft well-diffused light, but that the absorption of the glass is very low. An advantage is that it is easy to keep the lamp clean, as the surface is quite smooth. In appearance the bulb is a neutral grey. A coiled filament is used in order to reduce risk of breakage. Lamps of this form are being made in five standard sizes.

The New Zealand parliament has passed legislation, under the title of the Electric-power Boards Act, 1925, to consolidate the previous enactments dealing with the constitution and operations of electric power boards.

ELECTRICAL DEFROSTING OF MEAT

Australian beef is at a considerable disadvantage in competing on the British market against Argentine beef owing to the difference in the time occupied by transportation from the source of supply. The former has to be frozen to enable it to stand up to the long journey, while the latter need only be chilled. Frozen beef has considerably less value than chilled because of the losses sustained during defrosting. The usual method of thawing frozen meat is by hanging it in the atmosphere at ordinary temperatures for some days. The outer layers naturally thaw first and tend to become unfit for use before the inner portions are defrosted. There is also a considerable drainage of natural juices from the meat while hanging, which reduces the market value of the sound portions. These disadvantages do not apply to any great extent with mutton, owing to the comparatively small bulk of the carcasses and the consequent shorter time of hanging, but with beef they constitute a serious problem.

A solution appears to have been found, however, in the electrical defrosting of meat by a process patented by Mr. A. U. Alcock. The process makes use of the phenomenon of the generation of heat by the passage of an electric current through a resistance. A current of electricity is passed through the body of the meat, thus thawing the inmost portions even before the outer layers, and greatly accelerating the defrosting. A.c. energy is used so as to avoid electrolytic effects. The apparatus consists of a number of pronged electrodes, made of stainless steel mounted on fibre frames, which are driven into the frozen carcase at points which give approximately uniform current density in the thick and thin portions. Energy is supplied through a special self-regulating transformer which maintains a steady current flow under the varying conditions of resistance during the defrosting. The supply for the primary of the transformer may be taken from an ordinary plug or lamp socket. The maximum voltage applied is about 200 and the maximum current about 1.5 amps. The consumption of energy for defrosting a hind-quarter of beef is less than 3 kw. h.

It is claimed that the process practically eliminates the drainage or drip from the meat, owing to the fact that the inner portions tend to thaw before the outer, thus the outside frozen layers form a seal. In addition, the time of hanging is not greater than one day, thus deterioration is reduced to a negligible quantity.

The public works department of New Zealand is investigating the hydroelectric power potentialities of the west coast sounds.

ELECTRIC COOKING DEMONSTRATIONS

A series of demonstrations of electrical cooking was held at Moonee Ponds, Victoria, from Dec. 1 to Dec. 4. On the opening afternoon a talk on Electricity in the Home was delivered by Mr. T. H. McNaught, district superintendent for the state electricity commission of Victoria. The commission supplies electricity in the Essendon-Flemington area, which includes Moonee Ponds. The principal feature of the demonstrations, which were held in the afternoons and evenings, was the instruction given in cooking by means of McClary electric ranges supplied by Messrs. John Danks and Son Pty. Ltd. It was proved that every class of food could be cooked satisfactorily and economically by the electrical method. In addition demonstrations of various electrical household labor saving devices were given. An officer of the electricity commission was in attendance to explain technical points.

In his paper Mr. McNaught described the various uses to which electricity can be put in the home. He dealt with electric water heating, dish washing, clothes washing, ironing, vacuum cleaning and cooking, and mentioned the comfort to be derived from such appliances as electric fans. The strong point in favor of all the electrical appliances is the tremendous saving in labor resulting from their use. In addition the efficiency with which the work is done and the cleanliness and comfort attendant upon the use of electricity were stressed. It was also pointed out that the running costs of the electrical labor saving devices were remarkably low, particularly under the two-part tariff obtaining in the Essendon district. The first cost of electrical apparatus is certainly high but this may be offset by the fact that, in an all-electric home, the building costs are reduced; for instance, no wash-house or chimneys are required. In addition the saving owing to there being no need for hired help is very considerable. With electric cooking special stress was laid upon the fact of the superior quality of electrically cooked food.

An interesting feature at the demonstrations was a large dial and pointer attached to a meter, by means of which the audience could see the amount and cost of the current consumption. One revolution of the pointer took place for every unit consumed. The dial was divided into tenths, and points were marked off at $\frac{1}{4}$ d., $\frac{1}{2}$ d., $\frac{3}{4}$ d., etc., in accordance with the district tariff.

Perth city council proposes to float a loan of £150,000 for extensions to the electricity and gas supply and for miscellaneous works.

Tasmanian Hydroelectric Department

The hydroelectric department of Tasmania has issued its eleventh annual report, covering operations during the year ended June 30, 1925. This is the first year under the administration of Mr. H. A. Curtis as chief engineer and general manager. The department's principal undertakings are the 65,000 h.p. hydroelectric station at Waddamana, the h.t. transmission lines and substations giving bulk supplies to many centres both in the north and the south of the island, and the retail supply system of the city of Hobart. In addition the department operates a steam power station and feeder lines at Devonport, a transmission line from Lake Margaret to Zeehan, and a retail supply system for country districts near Hobart. New works in course of construction include a 13,000 h.p. hydroelectric station on the Shannon river near Waddamana, and a h.t. transmission line from Waddamana to supply the north-west portion of the state. A main substation for this supply is to be erected at Railton.

During the year several extensions to services were made. Substation equipment was installed at Electrona for giving an 11,000 volt supply to certain country towns, and several small towns were connected up; feeder lines were run from the Devonport steam station to supply Ulverstone and Penguin; a new generating unit was installed at Devonport; extensions were made to the country district services in the Derwent valley; the retail supply service in Hobart was considerably expanded. Several important contracts have been entered into for supply of large blocks of power. The Tasmanian Cement Co. has contracted for 3,000 h.p. and the Australian Shale Oil Corporation for 1,250 h.p. The Pioneer Woodware Co., at New Norfolk, also requires a power supply. There is good prospect of still further contracts being entered into in the near future.

During the year the output of the Waddamana power station was 284,000,000 units, with a maximum demand of 51,456 h.p. The capital expenditure on the bulk supply branch up to the end of the period was £2,696,171, and the revenue for the year was £164,141. The revenue from the Hobart supply amounted to £103,995. On the whole of the operations of the department there was a deficit of £20,170 for the year. The depreciation account, however, now stands at over £106,000. There is still a considerable surplus of power available for sale, and with a further increase of load the department should be able to show a financial surplus.

Parliament has recently appropriated the sum of £81,000 for the use of the department in

extending its undertakings. This includes items for the provision of power supply to the north-west coast towns, for the completion of the Devonport steam power station, for extensions to the retail country districts services, and for extensions to the retail supply in Hobart. The department has leased from the city council a site over the Hobart rivulet for the erection of a transformer station. The h.t. supply will be run in armored cables along the rivulet.

A select committee of parliament recently reported on the supply by the department of power to country districts. It considers that the present rates for bulk supply are too high and result in the prices charged by municipalities to consumers being so high as to limit the general use of electricity. The bulk supply rates are as follow:—For a maximum demand not exceeding 50 h.p., £15 per h.p. per annum; exceeding 50 h.p., but not exceeding 100 h.p., £14 per h.p. per annum; exceeding 100 h.p., but not exceeding 150 h.p., £13 per h.p. per annum; exceeding 150 h.p., but not exceeding 200 h.p., £12 per h.p. per annum; exceeding 200 h.p., but not exceeding 500 h.p., £11 per h.p., per annum; exceeding 500 h.p., but not exceeding 1,000 h.p., £10 per h.p. per annum. In all cases the minimum payment by the municipality must be £750 per annum. It was found that no municipality, other than Burnie, Devonport, and Ulverstone, had a demand sufficient to permit of its contracting for more than the minimum of 50 h.p., necessitating the payment of the maximum charge of £15 per h.p.

The prices charged to consumers by some of the local supply authorities are given in the following tabulation:—

	Light	Domestic power	Motor power
Hobart	5d.	1d.— $\frac{1}{2}$ d.	2d.— $\frac{1}{2}$ d.
Cygnnet	10d.	4d.	4d.
Longford	12d.	5d.	5d.
Penguin	10d.	3d.	3d.
Bothwell	12d.	4d.	4d.
Ulverstone	9d.	4 $\frac{1}{2}$ d.	4 $\frac{1}{2}$ d.—3 $\frac{1}{2}$ d.
Wynyard	8d.	4d.	4d.
Devonport	8d.	1 $\frac{1}{2}$ d.— $\frac{1}{2}$ d.	2 $\frac{1}{2}$ d.

In addition to the above charges the country municipalities levied lighting rates on ratepayers as follows:—Cygnnet, 1/-; Longford, 1/6; Penguin, 1/-; Bothwell, 1/6; Ulverstone, 1/3; Devonport, 1/-; Wynyard, 6d.—in the £1.

The general manager of the hydroelectric department is of opinion that the municipalities would reap considerable advantages by combining in groups to form power boards. The district demand would be larger than that of individual municipalities and thus supply could be given at lower rates. In addition administrative costs could be reduced. The committee, however, is not in accord with this view, but recommends that the hydroelectric department take charge of the retailing of electrical energy along similar lines to the operation of the Derwent valley country supply scheme.

TRAMWAY EXTENSIONS AT GEELONG, VIC.

Authority has been given for the Melbourne Electric Supply Co. to construct a new electric tramway at Geelong, running from the city through Geelong West to the suburb of Corio. Application is being made for authority to lay down another route running from the present Moorabool street terminus across the Barwon bridge and along the Colac road through Belmont.

ELECTRICAL WORKERS' BOARD, QUEENSLAND

Meetings of the board were held on Oct. 20 and Nov. 3 and 12. The crown law department has given a ruling that it is quite legal for the board to issue all the different classes of certificate to which a person might become entitled under the Electrical Workers' Act on the one form, provided each section of the form is signed by the chairman. In future, therefore, where a person holds more than one certificate they will be printed on one sheet.

The following amendment to clause 12 of the Electrical Workers' Act has been made by order-in-council:—"The board may allow any person who satisfies the board that he has been employed continuously in the electrical trade under the direction or in association with an employer, master, or journeyman, for a period of five years commencing not later than, and not more than three years prior to, the twenty-eighth day of September, 1923, and that at the commencement of such period he was under the age of twenty-one years, to apply for examination for a certificate of competency as an electrical fitter, an electrical mechanic, an electrical joiner, or an electrical linesman."

The board is not altogether in accord with a further order-in-council that has been made under section 33 of the Apprenticeship Act, which states that:—"A certificate of successful examination obtained by an apprentice electrician under section 33 of the Apprenticeship Act of 1924 shall be regarded as equivalent to a certificate of proficiency or competency required to

be obtained under section 5 of the Electrical Workers' Act of 1923."

Applications to sit for examination have been approved in the cases of three fitters, three linesmen, four fitters and mechanics and nine mechanics. Three certificates have been granted without examination.

FILM PUBLICITY FOR ELECTRICITY

An excellent form of publicity for popularising the use of electricity in the home was demonstrated recently at the Majestic theatre, Melbourne, when the Victorian electricity commission gave a first screening of its film, "The Uses of Electricity." The picture shows the performance of housework in an all-electric home. The uses and advantages of electricity for cooking, ironing, cleaning, clothes washing, dishwashing, water heating, lighting, radiators and fans, are clearly and attractively demonstrated. In addition, the average cost for performance of the various services is shown. Portion of the film shows how the advantages of electric service are being extended to country districts, and illustrates many applications of electricity on the farm, both to domestic and outdoor service. Attention is also drawn to the use of electric power for rural industries, such as woollen mills, butter factories, saw mills, etc.

Other films screened showed the progress of the works of the electricity commission. Views were shown at the Yallourn works, along some of the various transmission schemes and at the new Sugarloaf-kubicon hydroelectric works. It is intended to show the films in every picture theatre throughout the state, and also at public halls or any other place possible.

The Vereeniging power station, one of five supplying electrical energy to the Rand mines in South Africa, and controlled by the Victoria Falls Power Co., has been severely damaged by an explosion. The mishap is stated to have occurred through the breaking of a generator shaft. The Vereeniging plant comprises two 9,600 kw. A.E.G.-Curtis turbo-alternators and two 12,000 kw. turbo-alternators.

A sharp difference of opinion has occurred between parties in the Sydney city council over the appointment of Mr. G. S. Boyd as acting deputy general manager of the electric supply department. The general manager is in England on business connected with the extensions to the supply undertaking and in his absence the deputy general manager, Mr. S. Y. Maling, has been administering the department. The indisposition of the latter gentleman rendered necessary the further appointment. On a previous occasion Mr. R. Vine Hall acted as deputy general manager.

Radio News

A building at 167 Queen street, Melbourne, is being fitted up as the headquarters of the beam wireless services between Australia and England and Canada. The actual operations of sending and receiving messages will be performed from this office by remote control of the apparatus at the transmitting and receiving stations.

Several English amateurs report consistently good long distance working with Marconi T250 transmitting valves. Mr. G. Marcuse has transmitted speech and gramophone music to Kohat, India, on a wave length of 45 metres, and Mr. N. G. Baguley has communicated in Morse with the United States on a wave length of 45 metres with only 30 watts input. The latter has also established communication with New Zealand using the same valves.

Broadcasting station 3LO, Melbourne, is now operating on a new transmitter with effective power of 5 kw. The signals are of such strength that it has been found possible in the inner suburban area to get audible reception from a loud speaker operated from a crystal set. One valve gives good loud speaker reception. The benefit to country listeners in is very considerable and a good service is now available to the whole state both in daylight and darkness. The wave length is still 371 metres.

NEW HIGH TENSION STORAGE BATTERY

The Chloride Electrical Storage Co. Ltd. has recently put on the market a high tension battery of new design for wireless work, type W.H. The special features of this battery are: (1) It need only be charged once every six months when used for wireless or similar work. (2) The container is of moulded glass and no separators are required. (3) Plates are very robust. (4) The battery is supplied in a dry charged condition and can be put into commission immediately after filling with acid, but a freshening charge should be given during the first month. (5) No brass or other corrodible material is used. (6) Every plate is readily inspected, the acid level is clearly marked, and the mud space is clearly visible. The battery is made up in 12 cell units, thus giving 24 volts per battery. Tappings can be taken at every 12 volts. Suitable connecting clips are included with each battery. The actual capacity of the battery is 5,000 milli-amp hours when used on very small discharge currents such as are required in wireless apparatus. The normal charge current is $\frac{1}{4}$ amp.

HIGH POWER BROADCASTING

The present trend of broadcasting is to considerably increase the power of transmitting stations. In the United States experiments have been carried out recently on powers as high as 50 kw., and measurements have been made of the received signal strength from such stations. Contrary to expectations, the signals have not proved remarkably strong as compared with those from moderate powered stations. Excessive interference or blanketing of lower power stations is another element of the popular picture of superpower that has failed to materialise. The most startling conclusions are in reference to fading, or signal fluctuation. At all distances greater than about 50 miles from a station, actual tests show that the received wave intensity is continually fluctuating, the variation from maximum to minimum being as great as 100 to 1. Increasing the power was found to effect no improvement in the degree of fluctuation. The prime reason which makes high power desirable, however, is that it increases the effective radius of the station for giving dependable service. In other words, the higher the power the greater the distance over which the effects of static and other disturbances may be overcome.—“G.E. Review.”

THE REVOLVING BEAM DIRECTION-GIVING SYSTEM

An experimental installation has been made at the South Foreland, England, of Marconi's revolving short wave beam radio system for direction-giving to vessels at sea. The system is a special application of the principles of directional wireless transmission to the purposes of navigation. Signals are projected in a narrow beam of, say, 15 deg., and a different Morse signal is transmitted as the beam points successively to different selected points of the compass. The observing officer on the ship listens through the medium of a simple form of receiver and hears a series of perhaps five or more Morse letters as the beam sweeps slowly past the ship. The Morse letters which he hears tell him, by reference to a chart, the direction in which the beam is pointing at that instant, and therefore the bearing corresponding to the middle letter of the series of letters heard gives him his exact bearing in relation to the transmitter. The navigator is able to take any number of bearings at short intervals, and by coordinating these observations with the speed and course of the vessel he may determine his exact position by ordinary methods of triangulation.

The transmitting apparatus located at the South Foreland lighthouse comprises a valve transmitter which with the necessary generating machines and auxiliaries is housed in a small hut, and a unidirectional aerial system mounted on a revolving steel framework. The energy for the transmitter and for revolving the aerial is supplied from the Dover electricity undertaking. The valve transmitter operates on a 6-metre wave, the high-pressure supply to the anode of the valve being about 280 watts. The unidirectional aerial system comprises a number of energised aerals in a straight-line formation, together with a number of reflecting aerals arranged in a line parallel to the line of the energised aerals, the plane containing the reflecting aerals being approximately one quarter-wave length distant from the plane containing the energised aerals. All the aerals are vertical, and are approximately one wave length in height. Special arrangements are provided for ensuring that the currents induced in all the energised aerals are in phase with one another, and also that the phases in the top and bottom sections of these energised aerals are the same. The width of the aerial system is nearly four wave lengths, so that the plane area of this aerial system is nearly four square wave lengths.

The direction of maximum radiation is at right angle to the plane of the energised aerals, and in the direction away from the reflecting aerals. The aerial structure rotates continuously and the transmission of the distinctive signals is arranged automatically by means of plates representing the Morse characters, mounted on a large ring carried by the revolving structure, which actuate a contact mechanism as the structure revolves. Thus the operation of the transmitter is controlled so that the signal transmitted depends upon the direction in which the aerial is pointing. The range of action of the transmitter is approximately the same as that of a lighthouse, but the great advantage of the system lies in the fact that it is not affected by conditions of visibility. Tests indicate that it should be a very valuable aid to navigation.—“Electrical Review.”

LOW FREQUENCY HUM

Low frequency hum causes a great deal of annoyance to the broadcast listener and is sometimes very hard to deal with. It does not cause much actual distortion, but its presence is noticed as a background to all speech and musical reproduction. It may be due to induction from power mains, either in the aerial itself or merely in the amplifier, or possibly only in long leads with which many people wire their houses so that a loud speaker may be used in any room without the necessity of removing the receiver. In the first case, one usually finds that a

detector and low frequency valves are used, in which case the hum induced in the aerial is directly coupled to the grid of the detector valve, causing an output having the hum already superimposed on the signal. Where it is possible, a stage of high frequency may be introduced between the aerial and the detector valve, but sometimes this is undesirable. In this case the hum may frequently be cut out entirely or, at any rate, much reduced, by placing a large condenser, say, 0.1 microfarad, in the aerial earth lead. This, without cutting down the signal in the slightest makes a very high impedance path for the low frequency hum. When it is a case of induction in the amplifier itself it is another matter, however. Often the use of a large condenser in the earth lead of the amplifier has the effect of reducing the hum, but if not, earthing all the cores of the transformers, or surrounding the low frequency part of the amplifier with an iron case has to be resorted to. Changing the position of the amplifier may also have effect, but it is generally a tedious business to eliminate stray hums induced in the amplifier itself. Fortunately, however, this is only a very rare occurrence and often a very simple remedy is to be found.

The troubles introduced by the wiring of a house with long leads to enable a loud speaker to be used in any room without difficulty, are too often of a noticeable value to neglect, and the only sure remedy is to stop using the house wiring. The suitable use of condensers at intervals along the wiring may help, but as this nearly always introduces distortion, it is not to be recommended. These troubles nearly always occur in houses using an alternating current electrical supply, but are by no means unknown in houses using direct current supply, in which case it is the commutator ripple which is present. By knowing how a house is wired with the electric light supply mains it is frequently possible, by keeping as far away as possible from the lighting wires, to install a system of loud speaker or telephone wiring without entailing the hum, but there is always the likelihood of trouble and the installation should be carried out room by room, experiment being the only test. With a little care, however, and the observation of a few simple rules, it is often possible to wire a house in this manner, even when the hum has been detected to be quite objectionable when wired without any care whatever. A good test is to listen in at the set itself and then at the end of the wires, when any hum should be readily detected. It must, however, not be forgotten that the wiring has distributed capacity, and the effect of using a long length of twin wiring is exactly the same as placing a capacity across the loud speaker, the distortion being similar in quality.

—“Electrical Times.”

Trade Notes

The English Electric Co. of Australia Ltd. has removed from Broughton House, King street, to more commodious offices situate at 16 Barrack street, Sydney.

Agrippa Ltd. has been registered in New South Wales with capital of £10,000 to acquire from W. E. Grant and M. B. Bean, the rights and interests of the Agrippa electric holder. The subscribers are: M. B. Bean, W. E. Grant, L. Pavit, J. A. P. Martin, H. Austin, T. Simpson and G. W. Waddell.

Barker, Hull Electric Ltd., with nominal capital of £10,000 in £1 shares, has been formed in Sydney to take over the business of Barker, Hull and Co., and to trade as mechanical and electrical engineers, etc. The first directors are: T. Barker, W. H. Hull, H. R. G. Poate, C. O. Wagner, and T. W. Swain.

Monarch Electric Motors (Aust.) Ltd., with authorised capital of £10,000, has been formed to manufacture and market electric motors, elevators, etc. The directors are: R. W. Moore, W. J. Cowrie, and J. J. Carmody, and the registered office is at Ralph street, Alexandria, Sydney.

The Western Electric Company (Australia) Ltd. announces a change in name to Standard Telephones and Cables (Australasia) Ltd. with address as formerly. The company will continue to act as sole Australasian distributor of Western Electric products, including radio materials, domestic electrical appliances, telephones, wires, cables, and electrical accessories generally. The products offered and service rendered will be of the same high standard as heretofore.

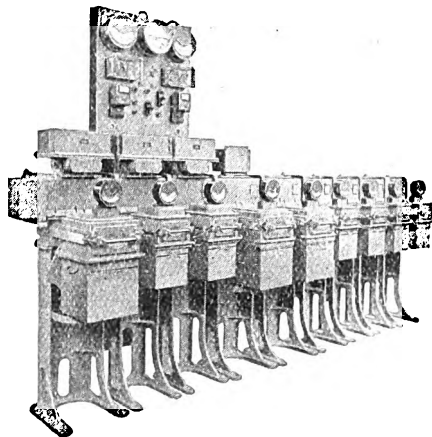
Plant For Sale.—Attention is directed to an advertisement on another page inviting purchasers for the following machinery suitable for an electrical supply undertaking:—One 450 h.p. Premier gas engine, two Mond gas producers, each 550 h.p.; one steam and one electrically driven Roots blower, together with spare parts. Inspection of the plant in operation may be arranged on application to Mr. J. Scoular, G.P.O. Box 3221 P., Sydney, from whom also photographs and fuller particulars are available.

Starting and Protecting Electric Motors.—George Ellison, England, manufacturer of electric control gear, has prepared an interesting booklet on the starting and protection of electric motors. It deals with the applications of the various types of starter, explaining the reasons for using the different equipment and the means adopted for protecting the motor during the starting and running periods. Illustrations of typical Ellison products are given, including circuit breakers, and star-delta, auto-transformer and

resistance starters. Messrs. Guthridge Ltd., Sydney, will be pleased to forward a copy of the booklet upon application.

Warburton, Franki Ltd., electrical engineers, Sydney, report a net profit of £4,312 for the year ended Sept. 30 last. The paid up capital of the company consists of 20,000 £1 preference shares and 16,000 £1 ordinary shares. Dividend on these at eight per cent absorbs £2,880. In addition to the payment of dividends £1,182 has been added to the general reserve and £250 to the depreciation reserve, these funds now standing at £11,143 and £2,250. The freehold and leasehold property of the company are valued at £15,962, stock on hand and work in progress at £28,916, and goodwill at £12,677.

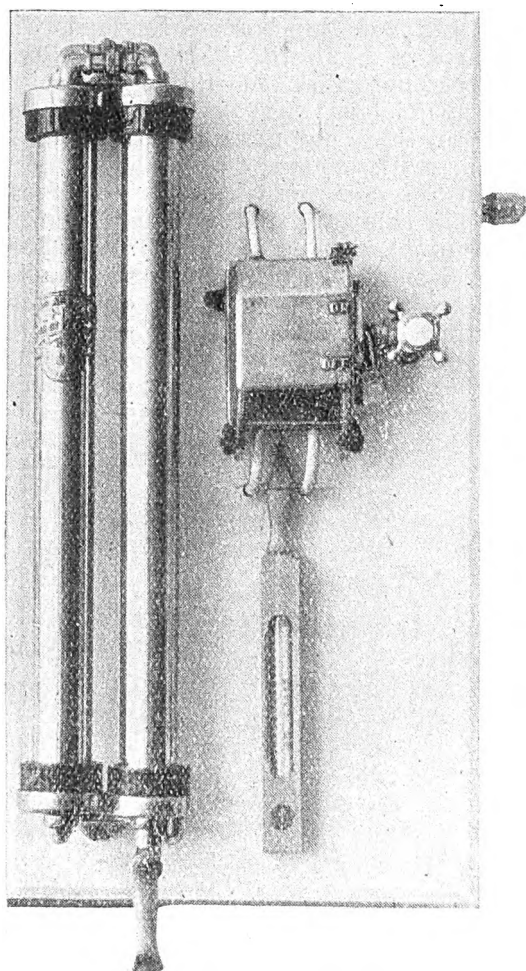
Mining Switchgear.—Messrs. Switchgear and Cowans Ltd., of Manchester, England, who are represented in Australia by Horrocks, Roxburgh Pty. Ltd., specialise in the manufacture of mining switchgear. The peculiar conditions of service for this equipment demand special construction, with sound design and first class workmanship, and these Messrs. Switchgear and Cowans are able to give. In general the switchgear is suitable for a.c. circuits up to 3,300 volts and for d.c. up to 650 volts, and in all cases the proved rupturing capacity of switches is considerably in excess of the rating. The gear is constructed in self-contained, totally enclosed, armor clad, oil immersed units, and combination switchboards are built up from these units.



Two forms of enclosure are standardised: Industrial, with cast iron oil tanks, and Explosion Proof, with welded boiler plate tanks. In the latter type wide machined flanges are used for all joints and the additional precaution is taken of filling the upper part of the circuit breaker case, the bus chamber, etc., with insulating compound. The circuit breakers are either of the drawout or non-drawout pattern, the former being designed for floor mounting on pedestals. Compared with a sheet-steel cubicle or flat-back type of switchboard the space required for the

accommodation of this class of switchgear is very small. The illustration shows a number of switch units connected up to form a board with interconnector panel, two alternator panels and six feeder panels. Adequate protection against overload, failure of supply or earth leakage can be provided, and mechanical and electrical interlocks are fitted which ensure correct sequence of operations and absolute safety to operators. In addition to the oil immersed lines the firm¹ manufactures air break switch and fuse gear in unit form for assembly into armor-clad boards.

Electric Bath Heater.—Efficiency, reliability and simplicity are the principal points claimed on behalf of the T.H.M. electric bath heater, an Australian invention which attracted a con-



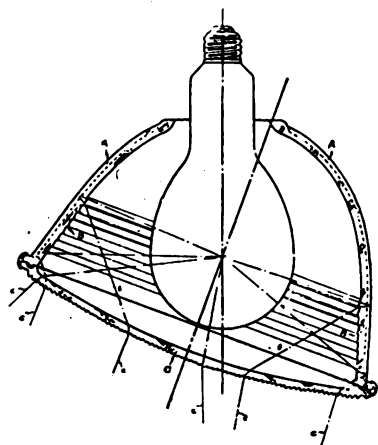
siderable amount of attention at the British Empire exhibition. The device consists of two metal tubular containers in which are the wire-wound elements and water circulation system, a tap for controlling the water flow and an ironclad switch for the electrical energy. The particular features of the heater are the special insulating base upon which the element is wound and the water circulation arrangement. The

insulating material has been found to stand up to the demands of service in a remarkable manner, thus ensuring the desirable reliability. The water circulation system is designed to promote efficiency. The incoming cold water is contained between an outer and an inner shell of the tube while the hotter water passes through a central tube surrounded by the heating element; thus the outer layer of cold water acts as lagging for the element, reducing radiation loss to the minimum. Under test the device has shown efficiency up to 97 per cent. The heater is absolutely safe to operate. The water tap and ironclad switch are interlocked so that the current cannot be turned on unless the water is flowing and the water cannot be turned off unless the switch is open. The energy consumption of the heater is 12 kw. and at this it will raise 90 gal. of water per hour from 48 to 100 deg. F. In summer weather it has been found to supply two gallons of water per minute at 115 deg. F. Hot water is available within 10 seconds of switching on. Increase of temperature can be obtained by regulating the flow of water. There is no danger of electric shock from the apparatus as all parts are solidly earthed. The device is supplied mounted on a base board complete with switch and water connections for £12/17/6.

In addition to the bath heater there are two models of T.H.M. water heaters, supplied at £5/10/- and £6/15/- respectively. These consist of a single heating tube with element rated at slightly under 3 kw., so that they may be connected to an ordinary power plug. These heaters will give a flow of 25 gal. per hour of hot water at a temperature suitable for lavatory basins, etc. All the heaters are supplied for a.c. or d.c. service at any of the usual voltages. The principle has been thoroughly tested at the Faraday House laboratories, England, and has been approved by the Victorian electricity commission and the Fire Underwriters' Association. Further particulars may be obtained from the manufacturers, Messrs. Thomas Abbott and Co., McEwan House, Little Collins street, Melbourne, who guarantee all heaters for 12 months.

Shop Window Lighting.—Holophane Ltd., London, has recently developed a totally enclosed shop window lighting unit of somewhat novel construction. It embodies a prismatic glass reflector and a refracting bottom plate designed to give a concentrated asymmetric distribution of light with a relatively small diameter. The use of a refractor allows of the reflector being made of smaller diameter than would be possible for an ordinary open mouth concentrating reflector. The reflector has radial double reflecting prisms on its outer surface and horizontal refracting ribbings on a portion of its inner surface, so arranged with reference to the light source and

the general contour of the glass that the reflected light is emitted at a depressed angle. The refracting screen over the face of the



Holophane Window Lighting Unit
 A.A.—Radial double reflecting prisms.
 B.B.—Interior horizontal refracting ribbing.
 c.c.—Concentrated and depressed rays.

reflector has on its outer surface concentric refracting prisms so formed as to concentrate and depress the light received direct from the lamp and that reflected back by the reflector. The form of the unit and its action will be understood by reference to the diagram. The result of the combined action of the parts is to give the greatest intensity of light immediately below the source, considerable intensity up to

high angles within the window and rapid falling off of intensity on the side toward the window glass. The light is thus provided just where it is required, and at the same time there is no glare. A strong point in favor of the unit is that the reflecting surfaces do not deteriorate from age or heat. The series of units is supplied complete with an adjustable lamp and reflector holder which can be fixed direct on to the ceiling or wood block without the need of any other accessories. The reflectors are supplied either with clear or opaque tops. Further particulars and prices are obtainable from the Australian representatives, Messrs. Robert Bryce and Co.

New Publication

Official Year Book of the Commonwealth, No. 18-1925. Issued by the Commonwealth Bureau of Census and Statistics.

This official year book is one of the most valuable reference works available; it is a veritable mine of information for those seeking information of a statistical or general character in regard to Australian industrial life. Primary and secondary industries, transport, water supply, manufactures, industrial legislation and a host of other matters are all reviewed and summarised. The present edition contains the full text of the Commonwealth Constitution Act, and a specially contributed article on Industrial Hygiene in Australia.

Lighting and Power

Ararat, Vic.—The borough council is considering the question of extending the electric supply plant.

Auckland, N.Z.—The Auckland power board has decided to open negotiations for the raising of £250,000 of the £650,000 loan proposal authorised.

Avoca, Vic.—Avoca Electric Light Co. Pty. Ltd., has been registered with capital of £5,000. The directors are J. J. McDonald, T. McLaughlin, A. C. Summers, A. F. Kaye and F. L. Burns.

Baulkham Hills, N.S.W.—The council is raising a loan of £11,500 for providing electric supply in part of the shire.

Bega, N.S.W.—A franchise has been granted by the municipal council to a private company to supply electricity throughout the town.

Bomaderry, N.S.W.—It is expected that electric supply from Port Kembla will be available within six months.

Byron, N.S.W.—The shire council has accepted tenders for switchgear, lightning arresters and lead covered cable for the electric supply undertaking. Mr. W. Corin is the consulting engineer.

Caboolture, Q'ld.—The shire council is arranging for a deputation to the state treasurer to ask for a loan of £6,000 for an electric supply undertaking.

Cambridge, N.Z.—The Cambridge power board now has 1,371 connections on its reticulation system, including 232 milking motors, 179 water heaters and 49 ranges.

Campbell Town, Tas.—In connection with the proposed electric supply scheme a minimum guarantee has been obtained from prospective consumers of 533 lights and 22 power points.

Casino, N.S.W.—The municipal electric supply scheme is well under way, the power house being nearly complete. It is expected that supply will be available early in 1926.

Charlton, Vic.—The directors of the Charlton E.L. and P. Co. report that the revenue for the last half year totalled £1,148, while the expenditure, including depreciation, totalled £918. During the period a crude oil set of 35 kw. capacity was installed at a cost of £1,531; £1,000 of this cost was borne by a loan, the remainder being provided out of revenue.

Cheviot, N.Z.—The council is considering the installation of a hydroelectric scheme.

Claremont, W.A.—The municipal council operates an electric supply undertaking, purchasing energy in bulk from the government power station, East Perth. During the last year the operations have been very successful. It has been decided to transfer £1,000 of the profits from the scheme to the council's general account, to form an electric supply reserve fund, and to review the charges for light and power.

Condobolin, N.S.W.—The electric supply undertaking was officially switched on on November 12. The distribution system is 415/240 volts, 50 cycle three phase a.c.

Mr. R. J. N. Franki, of Sydney, is the consulting engineer.

Cronulla, N.S.W.—As from December 1, 1925, the Sutherland shire council has taken over the electric supply undertaking of the Cronulla Electric Light and Power Supply Co. The contract price is £13,500.

Devonport, N.Z.—The question of selling the borough council's electric supply undertaking to the Waitemata power board is being placed before the ratepayers. Under the present system the cost of generation is high and it is not possible to make provision for depreciation without increasing the tariffs. The plant is working at full capacity and in the course of another two years at least £14,000 will be necessary for renewals. The conditions under which the borough would transfer to the power board provide that the board will take over the existing plant and all liabilities. A further clause in the agreement provides that until the hydroelectric power becomes available, no increase in charges will be made to Devonport consumers.

Dunedin, N.Z.—The Otago power board is taking steps to increase its gazetted inner area, and make extensions to the electric supply service.

Elmore, Vic.—The Elmore Electric Light and Power Co. is making alterations in its undertaking. Tenders have been accepted for the supply, delivery and erection of two 80 h.p. Ruston and Hornsby crude oil engines, and tenders are to be called for two 25 kw. generators. Also a new engine room is to be erected. The hours during which supply will be available are to be from 8 a.m. to midnight.

Finley, N.S.W.—Residents of the town are desirous of having an electric supply scheme installed.

Gerringong, N.S.W.—Mr. H. J. Hoggan, consulting engineer, Sydney, has been commissioned to furnish plans and specifications covering a modified electric light and power undertaking to cost approximately £4,500.

Glen Innes, N.S.W.—Mr. W. G. Counsell, engineer and manager of the Electric Energy Supply Co. Ltd., Warwick, Queensland, has been appointed to confer with Mr. W. Scott, engineer-in-charge of the municipal supply, on the question of improvement in service. It is anticipated that additional plant will be installed.

Grafton, N.S.W.—The first 12 months of operation of the Nymboida hydroelectric scheme concluded on Nov. 25. The engineer, in a report to the Clarence river county council, states that the weekly output at the power station has risen from 12,000 units in December, 1924, to 26,000 units at the present time. The number of consumers has reached 1,075, the connected load is 1,538 kw., and the maximum demand 400 kw.

Greensborough, Vic.—The electricity commission has made a start on the installation of electric supply for the town. The energy will be supplied from a tap off the 22,000 volt Thomastown-Dandenong transmission line at Watsonia. The supply will be extended to the Briar Hill district.

Hamilton, N.Z.—The Central power board has authorised its secretary to take steps if necessary to raise an overdraft up to £10,000.

Hamilton, Vic.—The Hamilton Electric Supply Co. is augmenting its plant by the installation of a 200 h.p. Crossley twin cylinder suction gas engine driving a 144 kw. E.C.C. generator.

Ingleburn, N.S.W.—The municipal council has adopted the plans and specifications of its consulting engineer, Mr. H. J. Hoggan, for an electricity supply undertaking to include Glenfield, Macquarie Fields and Mintaro. The estimated cost is £8,500.

Invercargill, N.Z.—The Southland power board proposes to introduce a new system of electric supply charges. For lighting a minimum charge of £5 per annum will be made, and for additional appliances such as ranges, motors, etc., minimum charges between £2/8/- and £10.

The energy charges will vary between 7d. and 1½d. per unit. Special rates of 1d. per unit for cooking and ¾d. per unit for water heating will be allowed.

Irymple, Vic.—The state school committee has installed at the school an electric generating plant capable of supplying energy for driving electric fans in the classrooms or for illuminating the grounds on special occasions.

Jamestown, S.A.—The statement, published last month, that the municipal council had received the authority of the ratepayers to sell its electric supply undertaking to the Adelaide Electric Supply Co. is incorrect. The council is inviting tenders for the purchase of the undertaking, the purchaser to enter into an agreement for carrying on the supply. Attention is directed to an advertisement in connection with this matter on another page.

Kangaroo Flat, Vic.—Messrs. Christie and Gardiner, of Melbourne, consulting engineers to the Marong shire council, have reported that the installation of an electric supply undertaking for the town would cost £1,415.

Katoomba, N.S.W.—The operations of the municipal electric supply scheme for the half year ended Sept. 30 (the first since the municipality took over the undertaking) have resulted in a net profit of £296. In addition to giving retail supply in its own area the council sells energy in bulk to the Blue Mountains shire council and the Blackheath municipality. The number of units sold for retail supply was 316,638 resulting in a revenue of £7,492. The revenue from bulk supplies was £3,032, and that from meter rents and sundries £558, making a total of £11,082. The running expenses totalled £8,358 and interest was £1,365. The council is extending the plant and has recently placed contracts as follows:—Two boilers, 2,100 sq. ft. h.s., chain grate stokers, boiler feed pumps, chimney stack and recording instruments, John Thompson (Aust.) Pty. Ltd.; economiser, E. Green and Son Ltd.; two 500 kw. Browett Lindley-Crompton alternator sets, transformers, lightning arresters, disconnecting switches, travelling crane, Crompton and Co. Ltd. The total capital cost of the new plant is £20,589.

Kerang, Vic.—The operations of the shire council's electric supply undertaking resulted in a profit of £877 for the year ended Sept. 30 last. The council has accepted the tender of Messrs. Vickers-Petters Ltd., for the supply, delivery and erection of one 69 h.p. and one 138 h.p. crude oil engine for the electric supply undertaking. The engines will be coupled respectively to 45 and 85 kw., 240 volt d.c. E.C.C. generators, supplied by Messrs. Lascelles Parrington Ltd.

Killarney, Q'ld.—An area surrounding the town has been declared a benefitted area for the carrying out of a hydroelectric scheme.

Koroit, Vic.—The price of electrical energy for lighting has been raised from 10d. to 1/1 per unit, with a minimum flat rate of £5/5/-. The power tariff will remain at 6d. per unit.

Lithgow, N.S.W.—The municipal council does not wish to renew its agreement with the Oakey Park Colliery Co. for bulk supply of electricity to the town. There is a possibility that supply will be obtained from the railway commissioners.

Mudgee, N.S.W.—A poll of ratepayers is being taken on the proposal to raise £20,000 for a municipal electric supply undertaking.

Mulgrave, Vic.—The electricity commission has signified its intention to erect h.t. mains and reticulate for electric supply in the shire. Supply will be given in the township of Clayton, in the area adjacent to Dandenong road, and along the Ferntree Gully road from near Oakleigh to Wheeler's Hill.

Napier, N.Z.—The Hawke's Bay power board is raising a loan of £300,000 for the electric reticulation of Hawke's Bay county and the Taradale town district.

Newcastle, N.S.W.—A dispute has arisen over the supply of electricity to portion of Lake Macquarie shire. The Newcastle city council desires to give supply, but it is alleged that the shire council has entered into an agreement, which has not been approved by the governor in council, with Caledonian Collieries Ltd., to take supply from the colliery plant. The attorney-general has threatened to proceed in the Equity Court against the shire council unless that body produce the agreement entered into with the Caledonian Collieries Ltd., but the company has made an offer to defend any proceedings or indemnify the council against any costs arising out of the proposed action.

Nyngan, N.S.W.—The municipal council has accepted tenders for plant for the electric supply undertaking. The generating sets will consist of two Vickers-Petters crude oil engines driving 25 kw. Crompton generators. Messrs. A. C. F. Webb and Burgess are the consulting engineers.

Oatlands, Tas.—The municipal council is seeking authority to raise a loan of £3,350 for the establishment of an electric supply undertaking.

Pukekohe, N.Z.—The Franklin power board has decided to trade in articles connected through a power meter, but not in lighting fittings.

Raetihi, N.Z.—The borough council is installing an additional generating set at its hydroelectric station.

Sheffield, Tas.—The Kentish municipality has been given authority to borrow £2,000 for an electric supply undertaking. Bulk supply will be taken from the hydroelectric department over a line seven miles in length from Railton.

South Perth, W.A.—The road board is raising a loan of £3,240 for extensions to the electric supply system.

Sutherland, N.S.W.—The shire council has accepted tenders for material for its electric supply reticulation and for the erection of same. Mr. H. J. Hoggan is the consulting engineer.

Tauranga, N.Z.—The question of amalgamation of the Tauranga and Bay of Plenty power boards has been raised. The Tauranga borough council has been asked whether it would consider the sale of the McLaren's Falls hydroelectric plant to an amalgamated board. The Tauranga power board contemplates raising a loan of between £25,000 and £50,000.

Te Aroha, N.Z.—The Thames Valley power board is to take further energy from the public works department by a tap from the 11,000 volt line running to Waihi. By this means it will be possible to give supply in the Waihi Plains district. The board is raising a loan of £50,000 and has further loan proposals under consideration.

Te Awamutu, N.Z.—The revenue of the Te Awamutu power board during September amounted to £1,712, nearly £400 in excess of that for the similar period last year. The new installations completed since April, 1925, are as follow:—House services, 112; milking motors, 62; other power motors (including 120 h.p. to Te Kawa quarries) 5; water pumping motors, 12; stoves, 20; grillers, 39; water heaters, 105.

Tuakau, N.Z.—Electric supply from the public works department's Horahora station, retailed by the Franklin power board, has been switched on.

Tumut, N.S.W.—Mr. R. E. Hales, of the public works department is investigating the possibilities of Jounama creek, for the development of electrical energy to supplement the Burrinjuck hydroelectric scheme.

Ulverstone, Tas.—The Leven council is seeking authority to raise a loan of £1,000 for extensions to the electric supply undertaking.

Unanderra, N.S.W.—A scheme is afoot to provide electric light and power for Unanderra, Brownsville, Mount Drummond and Dapto.

Underbool, Vic.—The progress association is asking the Walpeup shire council if it would be possible to make use of the small electric supply plant, now lying idle at Ouyen, for lighting the town.

Walgett, N.S.W.—Tenders are to be invited for an electric supply undertaking for the shire. Messrs. A. C. F. Webb and Burgess, Sydney, are the consulting engineers.

Wedderburn, Vic.—The Korong shire council is calling tenders for plant for an electric supply undertaking. The equipment called for includes crude oil engines, alternators, transformers, cables and meters. Mr. A. C. Bertoli, of Charlton, is consulting engineer.

Wellington, N.S.W.—The municipal council is raising a special loan of £15,000 for the establishment of an electricity undertaking. The estimated expenditure is as follows:—Power plant, £3,074; generators and switch-board, £1,287; building, £1,500; reticulation, £5,989; services, £1,600; contingencies, £1,550.

Willunga, S.A.—A poll of ratepayers of the councils of Noarlunga, McLaren Vale, Willunga and Dingabedinga resulted in a majority of 150 to one in favor of giving the Adelaide Electric Supply Co. power to extend its mains to the district.

Winton, Q'ld.—Tenders have been called for plant and equipment for an electric supply undertaking for the shire council. The generating plant is to be suction gas driven. Mr. A. E. Harding Frew, of Brisbane, is the consulting engineer.

Wollongong, N.S.W.—There are now 1,519 consumers taking supply from the council's electricity undertaking.

Current Prices for Electrical Supplies

The quotations in this list represent the average retail selling prices ruling in Melbourne during the month of publication. These prices are subject to bona fide traders' discounts. Special rates are obtainable in most cases for large quantities. In general Sydney prices are slightly lower.

Adaptors—

Hardwood	doz.	11/3
Parallel	each	6/6

Blocks—

3 in. round	gross	21/3
3½ in. round	gross	21/3
6 in. x 3 in. rectangular	doz.	6/3
9 in. x 3 in. rectangular	doz.	7/6
6 in. x 6 in. square	doz.	12/6

Bushes—

½ in. ideal metal	gross	7/6
¾ in. ideal metal	gross	7/6

Bushes—

½ in. ideal metal	gross	8/9
¾ in. plain wooden	doz.	1/6
¾ in. plain wooden	doz.	1/8
1 in. plain wooden	doz.	2/

Bells and Bell Material—

Bell transformers	each	10/6
1½ volt dry cells	each	3/
Bell wire—1/029 d.c.c.	1,000 yd.	32/6
1/036 d.c.c.	1,000 yd.	42/6
1/029 d.c.c. and i.r.	1,000 yd.	50/
1/036 d.c.c. and i.r.	1,000 yd.	60/

Bells and Bell Material—

No. 2 porous pots	each	2/
No. 2 jars	doz.	8/9
No. 2 zincs	each	1/3
Salammoniac	lb.	1/3
2½ in. wood box bells	each	4/6
2½ in. iron box bells	each	4/6
3 in. wood (church gong)	each	18/4
Bell presses	from each	3/9

Pocket Lamp Batteries—

Batteries, pocket lamp	each	1/10
2-cell batteries	each	2/5
3-cell batteries	each	2/8

Ceiling Roses—

	English	Japan
2-plate	doz. 10/5	5/5
3-plate	doz. 13/9	7/6

Connectors—

1-way, porcelain	doz.	2/6
2-way, porcelain	doz.	4/
3-way, porcelain	doz.	5/

Counterweights—

Porcelain	each	2/6
Brass	each	5/6
Shot for same	lb.	6½d.

Casing and Cover—

Best white pine	100 ft.	10/
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Conduit—

	Plain	Screwed
½ in.	100 ft. 8/9	20/
¾ in.	100 ft. 9/7	20/
1 in.	100 ft. 15/	27/6
1 in.	100 ft. 27/6	40/
1½ in.	100 ft. 45/	60/
1½ in.	100 ft. 68/	85/
2 in.	100 ft. —	135/
¾ in. oval	100 ft. 12/6	—

Conduit Fittings—

	½ in.	¾ in.	1 in.
Grip—Tees	doz. 3/10	3/10	4/8
„ Elbows	doz. 3/	3/	3/10
„ Couplings	doz. 2/3	2/3	3/
„ Crampets	gross 5/5	5/5	6/3
Saddles	gross 5/	5/	5/5

	½ in.	¾ in.	1 in.
Screwed tees	doz. 5/5	7/6	
„ elbows	doz. 3/9	5/5	
„ couplings	doz. 2/9	4/	
„ bell mouths	doz. 5/	5/	
„ „ „ 1 in.	doz. 14/10		
„ „ „ 1½ in.	doz. 19/6		
„ „ „ 1½ in.	doz. 27/		

Junction Boxes—

	½ in. & ¾ in.	1 in.
2-way	doz. 10/10	10/10
3-way	doz. 11/3	11/3
4-way	doz. 11/3	11/3

Fuses (Cut-outs)—

	British	Japan
5 amp, anchor type	doz. 10/	5/
5 amp, round chamber	doz. 17/6	8/9
8 amp, round chamber	doz. 20/	12/6
10 amp, oblong	doz. 35/	25/
20 amp, oblong	each —	3/

Holders—

	English	Japan
C/G., S/C. holders	doz. 11/3	8/4
½ in. and ¾ in. holders	doz. 11/3	8/4
Batten holders	doz. 12/6	9/2

Lamps—

	Metal Filament, Vacuum Type
25 to 250 volts, 20 to 60 watt	each 2/
20 to 250 volts, 100 watt	each 5/

Lamps—

	Gas-filled Type
20 to 250 volts, 25 to 40 watt	each 2/9
60 watt	each 3/3
75 watt	each 3/9
100 watt	each 5/3
150 watt	each 7/
200 watt	each 9/
300 watt	each 13/
500 watt	each 17/6
750 watt	each 22/6
1000 watt	each 27/6
1500 watt	each 40/

	Carbon Filament
All voltages, 5 to 32 candle power	doz. 24/
All voltages, 50 candle power	doz. 42/

Plugs—

5 amp two pin plugs	doz. 27/6
5 amp two pin tops	doz. 12/6

Shades, Opal—

8 in.	doz. 10/
9 in.	doz. 12/6
10 in.	doz. 15/

Switches—

	English
5 amp s.p. pol. brass	doz. 16/3
5 „ s.p. ox. copper	doz. 17/11
5 „ 2-way pol. brass	doz. 30/
5 „ 2-way ox. copper	doz. 33/
10 „ s.p. pol. brass	doz. 37/6
5 „ d.p. pol. brass	doz. 37/6
10 „ d.p. pol. brass	doz. 85/
5 „ s.p. ceiling switches	each 5/6
5 „ 2-way ceiling switches	each 6/6
1 „ ceiling switch and rosette	each 5/6
3 „ American tumbler	doz. 22/6
3 „ s.p. indicating rotary	doz. 24/
3 „ s.p. non-indicating rotary	doz. 22/6
3 „ 2-way rotary	doz. 56/3
5 „ d.p. indicating rotary	doz. 62/6
10 „ d.p. indicating rotary	doz. 75/
20 „ d.p. indicating rotary	doz. 150/

Switchboards—

	English	Japan
Single circuit marble 5 amp	each 9/9	8/
Single circuit marble 10 amp	each 17/6	16/3
Two circuit marble 5 amp	each 19/2	15/10
Two circuit marble 10 amp	each 25/	22/

Switchboard Frames—

6 in. x 6 in. local make	doz. 9/6
6 in. x 8 in. local make	each 1/
8 in. x 8 in. local make	each 1/3
8 in. x 10 in. local make	each 1/6
10 in. x 10 in. local make	each 1/8

Tape—

Black adhesive	lb. 2/9
Pure rubber	lb. 15/

Wire and Cables—

	Per 1,000 yd.
1/.044, 600 meg.	£7 3 4
1/.064, 600 meg.	10 5 0
3/.036, 600 meg.	11 15 0
7/.036, 600 meg.	20 10 0
7/.044, 600 meg.	26 0 0
7/.064, 600 meg.	43 10 0

Flexibles—

	Per 100 yd.
23/.0076 cotton	£2 5 0
40/.0076 cotton	2 16 8
70/.0076 cotton	3 11 8
110/.0076 cotton	4 13 4

Electrical Contracts

COMMONWEALTH

P.M.G.'s Dept., General.—2,080 extension switches—British General Electric Co.

P.M.G.'s Dept., S.A.—50 tons h.d. copper wire, 100 lb. per mile—British Insulated and Helsby Cables Ltd.

STATES

Sth. Aust. Supply and Tender Board.—Telegraph pole line material, 4,000 glass insulators, Hemingray No. 19, and 12 telephones, wall type—Unbehaun and Johnstone Ltd.; 150 miles copper line wire, 4,000 tapes for 200 lb. wire, 4,000 binders for 200 lb. line wire—Elder, Smith and Co. Ltd.; 30 lightning arresters—General Railway Signal Co. Pty. Ltd.; electro-mechanical signalling material—General Railway Signal Co. Pty. Ltd.; fibre angles and tubing—R. C. Forbes and Co.; 1 crude oil-driven generating set of 50 kw., 75-84 b.h.p., and 1 crude oil-driven generating set of 100 kw., 150-168 b.h.p.—Newton McLaren Ltd.; telephone train control electrical material, 4,400 glass insulators, 10 telephones, wall type, 4 telephones, wall type, 4 selector sets, 4 protectors, 4 selector keys—Unbehaun and Johnstone Ltd.; copper line wire, tapes and binders—Elder, Smith and Co. Ltd.

State Electricity Commission of Vic.—Switchgear—Metropolitan-Vickers Elect. Co. Ltd.; 6,600 v. and low tension insulators—Drayton Bros., Aust. Porcelain Co., Lawrence and Hanson Elect. Co. Ltd.; motor driven centrifugal pump—Crossle, Scott and Duff Pty. Ltd.; 6,600 v. trailing cable—Henley's Telegraph Works Co. Ltd.; switchgear and accessories—A. Reyrolle and Co. Ltd., c/o The English Elect. Co. of Aust. Ltd.; steel conduit and fittings—Lawrence and Hanson Elect. Co. Ltd., Noyes Bros. (Melb.) Pty. Ltd., Edison Swan Elect. Co. Ltd., Automatic Tube Co. Ltd.; galv. turnbuckles—Waters Mnf. Co. Pty. Ltd.; 6,600-v. transformers and spares—Weymouth's Ltd.; galv. steel strand—Elder, Smith and Co., B. K. Morton Pty. Ltd.; poles—Pettit, Robertson Pty. Ltd.

Victorian Railways.—Selector telephone apparatus—C. R. Foster; two motors—Crompton and Co. Ltd.; two selector telephone keyboards—C. R. Foster; carbon brushes—Australian General Electric Co. Ltd.; signal lamps—Lawrence and Hanson Electrical Co. Ltd.; hard-drawn bare copper cable—British Insulated and Helsby Cables Ltd.; wire, line, copper clad, braided, weather-proof—Henleys Telegraph Works Co. Ltd.; hard drawn bare copper cable—British Insulated and Helsby Cables Ltd.; three phase alternating current induction motor, starting apparatus and accessories—Noyes Bros. (Melb.) Pty. Ltd.

Victorian State Coal Mine.—Lamps, E.S.M.F., 60 watt, 240 volt, 1,000—Wm. McLean and Co.; 100/240 volt, 100—Australian General Electric Co.

GENERAL

Katoomba Municipality, N.S.W.—Two boilers, 2,100 ft. H.S., chain grate stokers, boiler feed pumps, chimney stack and recording instruments—John Thompson (Aust.) Pty. Ltd.; economiser—E. Green and Son Ltd.; two 500 kw. Browett Lindley engines coupled to Crompton alternators, switchgear, transformers, lightning arresters, disconnecting switches, travelling crane—Crompton and Co. Ltd.

Melbourne and Met. Tramway Board.—Storage battery plates—Tudor Accumulator Co. Ltd.

Melbourne City Council.—500 clear glass lantern globes—Dott and Co. Pty. Ltd.; 36 chain grate stoker links for boiler-house plant—Combustion Engineering Co. (Aust./sia) Pty. Ltd.; 1 centrifugal pump—Crossle, Scott and Duff Pty. Ltd.; 12 automatic time switches—H. Rowe and Co.

Metropolitan Water, Sewerage and Drainage Board, Sydney.—37 single phase watt-hour meters for switch-board mounting—Electricity Meter Manufacturing Co. Ltd.

Nyngan Municipality, N.S.W.—Two 25-kw. Vickers-Petter oil engines coupled to Crompton generators—Buzacott and Co. Ltd.; reticulation—Commonwealth Electric Co.; switchboard—Electrical Manufactures Ltd.; meters—Landis and Gyr; house service fuses—Electrical Manufactures Ltd.

Sutherland Shire, N.S.W.—Erection of substations—F. H. Sorensen; erection of poles and outside reticulation—D. H. McKenzie and Son; h.t. and l.t. pin type and shackle type insulators—Canney and Towe, Australian General Electric Co. Ltd.; hard drawn bare copper cables—William Adams and Co. Ltd.; single phase watt hour meters—Electricity Meter Mfg. Co.; 11,000 v. distribution transformers—English Electric Co. of Australia Ltd.; street light fittings, constant current transformers, switchgear and lightning arresters—Electric Control and Engineering Co., Australian General Electric Co.; wood poles—Canney and Towe.

Sydney City Council.—Asbestos cement troughing—James Hardie and Co. Ltd.; direct current feeder panels—Australian General Electric Co.; L.T. underground cables—W. T. Henley's Telegraph Works Ltd.; rubber insulated cables—Messrs. Newell and Buckley Ltd.; glazed stoneware bridges—Lawrence and Hanson Electrical Co. Ltd.

NEW ZEALAND

Auckland Electric Power Board.—Troughing—Napier Concrete Co.; bare cable—National Electrical and Engineering Co.; cable—Lawrence and Hanson Elect. Co.

Christchurch City Council.—16 200-kv.a. distribution transformers—Metropolitan-Vickers Elect. Co.; motor pumps—National Elect. Engineering Co.; ammeters—A. D. Riley and Co.; underground cable and boxes for substations—Turnbull and Jones; oil testing transformer and accessories—National Electric Co.

Dunedin City Council.—Bare cable—Samuel Brown Ltd.; triple braided cable—National Elect. Engineering Co.

Franklin Electric Power Board.—No. 5 wiring contract (72 installations)—Wilson Electrical Co.

Gisborne Borough Council.—Two hundred electricity meters—A. D. Riley and Co. Ltd. (Ferranti).

Grey Electric Power Board.—12 sets choke coils—Allum Electric Co.; 12 sets lightning arresters—National Electric Co.; 6 single throw air break switches—Canterbury Engineering Co.

Malvern Power Board.—30 miles of hard-drawn copper wire, No. 68—Carrick, Wedderspoon Ltd.

Marlborough Electric Power Board.—Approx. 2,000 house service meters—Carrick Wedderspoon Ltd.; strain insulators—Richardson, McCabe and Co.; generators and spares—British General Electric Co.; steel-reinforced aluminium cable—Richardson, McCabe and Co.; pin insulators—Carrick Wedderspoon.

Public Works Dept.—Waikato, section 142: electric ranges, oil-engine—Vickers Ltd. (Petter); frequency meters—Metro-Vickers Elect. Co.

Rangiora Borough Council.—Electrical installation, new town hall—Turnbull and Jones Ltd.

Wairarapa Electric Power Board.—Transformers: ten 15-kv.a.—A. S. Patterson and Co.; 50 kv.a.—Metropolitan-Vickers.

Waitemata Electric Power Board.—Transformers: A. S. Paterson and Co. Ltd. (Swedish General Electric); meters—A. D. Riley and Co.

Waitomo Electric Power Board.—Pole ironwork—T. and J. Anderson.

TENDERS OPEN COMMONWEALTH

P.M.G.'s Dept., General.—Dec. 22—Accumulators and C.E.M.F. cell batteries. Dec. 29—Magnet and resistance wire. Jan. 26—Cord tags, resistances and reactances. March 2—Condensers. March 9—Telephone cord circuit relays, instrument cords. March 16—Ringing generators and polechangers, power board equipment, Adelaide exchange. March 23—Magneto trunk switchboards, telephone switches.

Works and Railways Dept.—Jan. 4—D.C. motors.

STATES

N.S.W. Public Works Dept.—Jan. 11—66,000 v. lighting arresters. Feb. 1—Two 3-ton electrically driven pedestal jib cranes.

N.S.W. Railways and Tramways.—Dec. 23—Air cooler. Jan. 13, 1926—Four 3,000-kw. rotary converter units; 1,000-kv.a. transformer. Jan. 20—Two 500-kw. rotary converter units. Jan. 27—Two 500-kw. converter units, car equipments for 101 motor cars and 101 trailer cars. Feb. 10—Time extended—traction motors. Feb. 17—1,500-volt d.c. switchgear. March 3—11,000 volt iron-clad switchgear. March 10—Stokers or pulverised fuel equipment.

State Electricity Commission of Vic.—Dec. 29—1,000 kv.a. transformers. March 29—Transformer and auxiliary apparatus for obtaining neutral point. April 12—Spec. 26/1 turbo-generators, transformers, switchgear, cranes and accessory plant for Sugarloaf-Rubicon hydro-electric scheme.

Victorian Public Works Dept.—Dec. 24—Installation electric lighting and power Emily McPherson college of domestic economy.

Victorian Railways.—Dec. 23—Time Extended—Fibre. Dec. 30—Time Extended—Insulated copper wire. Jan. 13—Insulating varnish, portable double recording watt meter, auto transformer starters. Jan. 20—Automatic battery charging equipment, fire resisting insulated cable. Feb. 3—Stranded copper cable, G.I. telegraph wire. Feb. 10—Time extended—Power totaliser and transmitter, total power recorder, and total power indicator, alternating current power point mechanisms.

GENERAL

City Electric Light Co., Brisbane.—Jan. 6—Lead covered house service cable, 200 kv.a. transformers.

Korong Shire, Victoria.—Jan. 5—Crude oil engines, generating plant and equipment.

Melbourne and Metropolitan Tramways Board.—Dec. 22—Four-motor equipments and air brake equipments.

Melbourne City Council.—March 8—Totally enclosed armored type switchgear.

Metropolitan Water, Sewerage and Drainage Board, Sydney.—Jan. 7—Two 500-h.p. a.c. motors and starters.

Rylstone Shire, N.S.W.—Feb. 5—Electricity reticulation.

Sydney City Council.—Jan. 4—Galv. solid drawn screwed conduit. Feb. 1—Steam turbo-alternator plant, automatic reclosing equipments for H.T. feeder switches. Feb. 8—Steam raising plant, L.T. underground cables. Feb. 15—Transformer tanks. Feb. 22—Power house switchgear.

Walgett Shire Council, N.S.W.—Jan. 12—Electricity supply scheme.

Winton Shire Council, Q'ld.—Jan. 25—Generating plant and equipment for town electric supply.

NEW ZEALAND

Auckland Electric Power Board.—Feb. 8—Overhead cotton covered cable. Feb. 22—Cut-outs.

Christchurch Drainage Board.—Jan. 5—Three electrical centrifugal sewage pumping plants.

Franklin Elec. Power Board.—Jan. 9—11,000 volt feeder

panels and switchgear, busbar pillar insulators, change-over switches, lightning arresters.

Hastings Borough Council.—Feb. 1—500 b.h.p. Diesel engine, and alternating current generator.

Otago Harbor Board.—Jan. 29—Two 60-h.p., one 30-h.p., one 7½-h.p. motors, 25 kw. generator ammeter, control drive and sprockets.

Public Works Dept.—Jan. 19—50,000-volt switchgear, section 141, synchronous condenser, section 176, 110,000-volt switchgear. Jan. 26—50,000-volt switchgear, section 139; 11,000-volt switchgear; four 4,000-kv.a. transformers, 50,000 lightning arresters. Feb. 16—Outdoor switchgear, Waikato scheme. March 2—Section 190 Lake Coleridge, 33,000 volt switch and protective apparatus. Section 150, Arapuni, synchronous condenser and transformers.

POSITIONS VACANT

Those requiring the services of electrical engineers are advised that a list of men open for engagement is filed by the Editor of this journal. All enquiries will be treated as confidential if so desired.

The Queensland public service commissioner invites applications up till December 22 for the position of instructor in the correspondence course leading to the examinations under the Electrical Workers' Act. Salary from £340 to £450 per annum. Applicants should have a good theoretical and practical knowledge of the electrical trades.

MUNICIPALITY OF MULLUMBIMBY ELECTRICAL ENGINEER

APPLICATIONS, endorsed as such, will be received by the undersigned up to 5 p.m. on SATURDAY, the 19th DECEMBER, 1925, for the position of Electrical Engineer to the above Council. Salary, £450 per annum. All other particulars of duties may be had on application to the Council's Consulting Engineer, Mr. W. Corin, 28 O'Connell Street, Sydney, or the undersigned.

Section 95 of the Local Government Act will be observed when making appointment.

C. H. BOXALL,
Town Clerk.

Council Chambers, Mullumbimby, N.S.W.,
December 9, 1925.

SHIRE OF KORONG

Tenders—Electric Supply Department.

Tenders, endorsed "Electrical Machinery and Apparatus," and addressed to the President of the Shire, Shire Hall, Wedderburn, will be received up to the 5th January, 1926, for the following sections:—

- 1—Crude Oil Engines.
- 2—Alternators and switchboard.
- 3—Transformers, High Tension Cut-outs.
- 4—Copper Cables, Aluminium Cables.
- 5—Belting.
- 6—A. C. Meters.
- 7—Sundry Apparatus.

Plans and specifications may be had upon application to A. C. Bertoli, Power House, Charlton, Victoria, for which a fee of £1/1/- (by cheque) will be charged, and which sum will be refunded upon receipt of bona-fide tender.

Specifications may be viewed at the Office of the Municipal Association, Melbourne.

The lowest or any tender not necessarily accepted.

C. C. MURRAY,
Shire Hall, Wedderburn, Vic.,
2nd December, 1925.

FOR SALE

1 Premier Gas Engine, 450 B.H.P.; 2 Mond Gas Producers, each 550 H.P. for working Producers alternatively; 2 Roots Blowers, one steam, one electrically driven. Number of spare parts. Particulars and Photos of Plant.

J. SCOLAR, Consulting Engineer,
G.P.O. Box 3221 P., SYDNEY, N.S.W.





Editorial





DANGER WITH HIGH TENSION OVERHEAD TRANSMISSION

A sad accident occurred recently near Hamilton, New Zealand, when two persons were electrocuted through coming into contact with a wire fence across which a conductor of a high tension line had fallen. Unfortunately this is not the first fatal accident that has arisen from a similar cause. Under favorable conditions it is quite possible for portion of a line to drop from its support without making an earth connection of sufficiently low resistance to cause tripping of the protective apparatus. Where this happens without the conductor coming into contact with any normally harmless metal, the loose line acts to a large extent as its own warning of danger, for the average person is sufficiently informed about the properties of electricity to keep well clear. But when a line falls on to a wire fence, and remains insulated from ground by dry wooden posts the danger is very serious. It is quite possible for a fence to become charged thus for several miles and there is nothing to indicate its dangerous condition except visual observation of the point of contact between wire and fence.

The outstanding feature of the matter is that, unless very exceptional circumstances arise, the power lines should not come down. Breakages through unforeseen stresses imposed by natural phenomena such as lightning, high winds or floods are understandable. In such cases the failure is usually of a nature that will cause an electrical shut-down. But breakages that do not throw the line out of circuit generally arise from defects either in the design or the material of the line. There is room for grave doubt whether, in the case of light lines in particular, sufficient attention is paid to mechanical strength. The present tendency is to use long spans between poles, with a result that although the conductor may have ample section to carry the power for which the line is designed, it is not always strong enough to withstand the mechanical stresses which may be imposed upon it. The straining of the wires alone puts a fairly severe load on the metal. In computing the cross section to give the requisite strength account must be taken also of the possibility of fatigue of the metal near the points of support, under the varying stresses and the sway induced by wind fluctuations. Careful attention to these points alone should practically eliminate line failures.

But there are still precautions that should be taken in order to guard against accident through unforeseen circumstances. In the case of power lines crossing each other or crossing telephone lines or railway or tramway tracks it has long been customary to take action to prevent contact being made from one line to the other. But apparently the crossing of a power line over a wire fence has been overlooked. Some supply authorities are already recognising the danger and taking steps to combat it; indeed, the very authority whose line caused the recent fatalities has just concluded experiments with leakage protection for tripping lines on much lighter current adjustments than can be dealt with by fuses or circuit breakers. This is an effort in the right direction, and the installation of such protection should result in immunity from fatal accidents in the future.

While adequate protection is desirable there is a possibility of the matter being over-done. This, it appears, is what has taken place in England, where regulations prescribe such precautions in connection with overhead h.t. transmission that the distribution of energy in lightly loaded areas is severely handicapped. This is a situation that must be avoided. Reasonable care can be taken without undue expense, and one or two unfortunate occurrences must not be allowed to give rise to a mania for expensive protective apparatus. The use of leakage protection for overhead wires, while quite satisfactory from the point of view of the safety of the public, has not proved altogether advantageous to either supply authorities or consumers. In the first place, the protective equipment is somewhat expensive, making an unduly heavy charge on the cost of distribution, particularly in areas of scattered loading; and secondly experience has demonstrated that leakage protection is too sensitive for overhead equipment, being liable to interrupt the service for very trivial causes.

Earthing of the neutral at the generating station at least, is now almost universal practice in three phase work, and it would appear that quite satisfactory protection to both life and property should be obtainable by the use of circuit breakers and fuses for automatically cutting the line out of service, and by solidly earthing dead metal in the immediate vicinity of the line. A quite inexpensive earth for a wire fence would, in the event of a line making contact with the wire, allow sufficient earth current to flow to trip the automatic protective

apparatus. Each case, of course, must be treated on its merits, but it would appear that compliance with the above suggestion would at least eliminate the more subtle dangers arising from a mechanical line failure.

SCIENCE AND ART IN STREET LIGHTING

During the last few years street lighting methods have undergone a change that might almost be termed revolutionary. The credit for this must be given to the manufacturers of lighting equipment and the electric supply authorities: to the former for painstaking research into the scientific principles underlying the provision of adequate lighting, and for the development of equipment that makes possible the putting into practice of these principles; and to the latter for co-operating with the manufacturers in educating civic authorities and the general public in regard to standards of illumination, and creating a desire for improvement. There is yet a great deal to be done in the educational direction, for old custom dies hard, and although it may not be difficult to convince the right authorities that the old lighting systems are not the best, it certainly is hard to drive home the assurance that the increased expenditure involved in a scientifically designed installation is justifiable. Nevertheless, a good start has been made, and each new installation put in under the influence of modern ideals constitutes a fresh argument in favor of the universal betterment of street lighting.

The three basic considerations which go to make up scientific lighting practice are: (1) Efficient generation of the light, (2) even distribution of illumination and elimination of waste light, (3) avoidance of glare. The best service in fulfilling the first requirement is obtained by the use of gas-filled electric lamps. The second and third requirements may be met by the use of proper reflecting and refracting apparatus for directing the light. But with these last requirements a difficulty arises from the fact that they are to a great extent opposed one to the other. Considerations of economy dictate that the lighting units be placed as far apart as possible, with due regard to the results to be obtained. This means that the light from the lamp should be redirected in a manner that will throw it far along the street. Now it is obvious that with the rays thus directed the source of light will show up with considerable brilliance to persons coming towards it along the thoroughfare. Attempts to diminish this glare will tend to considerably reduce the distance over which the requisite intensity of illumination is obtainable.

Careful study, however, has disclosed means by which these two conflicting factors may be brought into harmony. One is by using high mounting for the light units, and the other by increasing the size of the light source so that the intensity covers a comparatively large area, thus reducing the intrinsic brilliancy of the unit. The former method has been used for many years and it has much to commend it, but there are certain situations where it is inapplicable. For instance, a boulevard planted with shade trees cannot be satisfactorily illuminated by this means as the trees interrupt the rays and cast confusing shadows. In this case it is essential that the source of light be beneath the trees, and therefore at no great height above the ground. With low set lighting units the glare difficulty may be overcome by the second method, i.e., by covering the lamp with a large refracting and diffusing globe which becomes the virtual light source.

But there is yet another aspect of street illumination that is of great importance. The lighting equipment performs its useful function by night, but it must be remembered that the fittings remain in position during the day, and therefore it is essential that particular care be given to their appearance. In a purely industrial area this is not so necessary, but in a residential district or on an ornate highway the units should be chosen to harmonise with their surroundings. The manufacturers of equipment have kept this view of the question before them, and in consequence lanterns and standards are available in many beautiful designs. Such is the skill and taste with which science and art have been combined in the design of many of these fittings that the presence of a modern lighting installation lends dignity and beauty, both by day and by night, to the thoroughfare which it graces. This may be exemplified in one instance by reference to the new installation recently put into operation by the Melbourne city council on St. Kilda road, which is described and illustrated on another page. The old lighting tended to detract from the beauty of the thoroughfare, but the new installation lends additional charm.

Notes and Personals

Mr. A. J. Veall, the well-known Melbourne trader and contractor, left for England recently by the Orama.

Mr. J. D. Birrell, special representative in New Zealand for the Westinghouse Electric and Manufacturing Co., returned to the Dominion recently after a six months' visit to the United States.

Mr. W. J. Dennis, of the staff of the Electric Supply Co. of Victoria Ltd., has been appointed electrical engineer to the borough of Eaglehawk.

Mr. W. S. Wright has resigned from the position of lecturer in electrical engineering at Auckland university college.

Mr. L. J. Salmon, one of the victims of the recent crash on the Maroubra, N.S.W. motor speedway, was formerly representative of the Liverpool Electric Cable Co.

Mr. H. P. Colwell, chief electrical engineer of the Victorian railway department, returned to Melbourne by the Orama after a trip to America and Europe.

Mr. E. Robinson, A.Am.I.E.E., has commenced practice at 82 Pitt street, Sydney, as a consultant in the design, layout and supervision of industrial power plants.

A bill has been passed granting the Victorian electricity commission an extension of time for the payment of interest on advances from the treasury from June 30, 1925, to June 30, 1928.

A report on the operations of the Christchurch, N.Z., tramways shows that for the four weeks ended Oct. 18 there was an increase of 18,620 passengers carried over those for a similar period last year. This increase has taken place in spite of the fares being raised. The increase in revenue was £2,092.

Mr. Hector Sleeman, formerly with the Australian General Electric Co., has been with the Rangoon (Burma) Electric Tramway and Supply Co. Ltd. for the past 18 months. Prior to that he was construction superintendent with the B.T.H. Co. in India.

Mr. J. H. Hindman, manager of the electricity department of the Greater Brisbane council, met with an accident recently when his car went over an embankment at Taringa. Mr. Hindman had been inspecting some work recently completed for the council, and had a remarkable escape from serious injury.

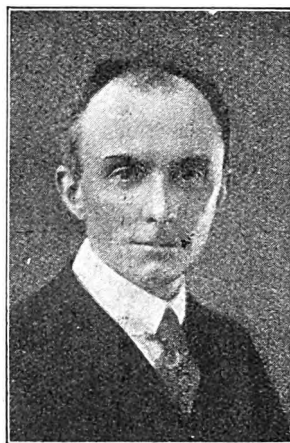
Mr. A. U. Alcock, a director of Messrs. Herbert Del Cott Pty. Ltd., Melbourne, returned last month by the Orama from a trip to Europe. Mr. Alcock was one of the Australian representatives at the international conference of large electric high tension systems in Paris in June last.

Professor W. H. Warren, who resigned from the position of professor of engineering at Sydney university at the close of last year, died on January 9. He had been 43 years in the service of the university, having organised the school of engineering in 1883. He was a past president of the Institution of Engineers, Australia, and had been appointed emeritus professor of the Sydney university from Jan. 1, 1926.

Mr. W. Hoper, of Coraki, has been appointed electrical engineer in charge of the Mullumbimby municipal council's hydroelectric station at Wilson's creek, N.S.W.

The Victorian parliament has passed a bill increasing the borrowing powers of the Melbourne tramways board from £3,000,000 to £4,000,000. The additional money is required for conversion of the cable tramways to electric traction and for extensions to the electric system.

Mr. M. C. Timms, of Messrs. Siemens Bros. and Co. Ltd., Melbourne, leaves for England at the end of January to take up an important technical appointment in the cable works of his company at Woolwich.



He will be dealing largely with research work and new developments in electric cables. Mr. Timms is well known to readers of this journal through his valuable contributions on the technique of cable practice. He intends, as time permits, to continue to contribute

articles on subjects of interest that arise in connection with his work.

Mr. L. Mandeno, electrical engineer to the borough of Tauranga, N.Z., recently resigned his position under circumstances which called forth a protest from many of the ratepayers against the council accepting the resignation. The council, however, while acknowledging the services of Mr. Mandeno to the borough, declined to change its attitude. Mr. E. W. Boak, of the New Zealand Co-operative Dairy Co., has been appointed to the vacancy.

HYDRO-ELECTRIC POWER IN TASMANIA

In the eleventh annual report of the hydro-electric department of Tasmania reference is made as follows to the publication, "Hydro-Electric Power of Tasmania," issued from the office of this journal:—"An illustrated book on 'Hydro-Electric Power in Tasmania' was produced some months ago and published by the Tait Publishing Company, Melbourne, in a very attractive and interesting manner. This production has been widely circulated throughout the world, attracting a very considerable amount of interest and giving our waterpower resources a tremendous amount of publicity."

NEW CAPITAL FOR VICTORIAN ELECTRICITY COMMISSION

The Victorian parliament has passed a bill granting authority to take from loan funds the sum of £1,841,000 for extending the undertakings of the electricity commission. The schedule of works for which the money is required is as follows:—

Sugarloaf-Rubicon hydroelectric scheme	£150,000
Supply to country districts and extra-metropolitan areas	195,000
Extensions of main metropolitan high-tension distribution system	225,000
Service extensions	104,000
Conversion of electric supply system in areas of supply of The Melbourne Electric Supply Co. Ltd.; and provision of advances for other purposes	342,000
Yallourn open cut workings	160,000
Yallourn township (extension)	70,000
Yallourn briquetting factory (extension) . .	50,000
Provision of service buildings, equipment and minor works	70,000
Working capital for Yallourn operations . . .	210,000
Other expenditure (including payment of interest)	265,000
	£1,841,000

When the bill was before parliament it was pointed out that, although the commission's liabilities already totalled £8,772,153, the additional money was absolutely essential to the proper carrying on of the scheme. The demand for electrical energy was continually increasing and adequate provision must be made for giving supply. Even already the lack of some of the works included in the schedule was seriously impairing the efficiency of the commission's operations.

Speaking before members of parliament in defence of the commission's activities, Sir John Monash stated recently that the loss of approximately £250,000 on the operations for last year was anticipated. A similar loss was inevitable with any large undertaking first coming into operation, before full loading was attained. Sir John considered that the full load would be reached in about 15 months and that then the total revenue would reach £1,000,000 per annum. This would be sufficient to meet all operating costs and interest. The commission had been criticised because the original estimate of £2,600,000 expenditure had grown to £9,000,000, but this was because the original estimate was for the Yallourn scheme alone, whereas the final cost was due to the addition of many new undertakings authorised by parliament.

Sir John also stated that, although the moisture content of the coal from the new open cut at Yallourn was higher than anticipated the coal could be burned and briquetted satisfactorily. The commission was continuing to work the moist deposits because the capital has already been invested there and because the deposits are very extensive.

As regards briquettes, Sir John is of opinion that when the factory is extended the production costs will be considerably reduced. The commission considers that the present method of selling briquettes through the fuel merchants is unsatisfactory and therefore it intends to establish depots for direct dealing with the public.

VICTORIAN ELECTRICITY COMMISSION INQUIRY

The Victorian government has appointed Mr. Willett H. Sawyer to conduct the promised inquiry into the operations of the electricity commission. Mr. Sawyer is an executive of the North American Co., a financial holding concern



Willett H. Sawyer

which controls a large group of public utility companies in the United States of America. Amongst the subsidiary companies of the North American Co. are the Cleveland Electric Illuminating Co., the Milwaukee Electric Railway and Light Co., the Union Electric Light and Power Co. (St. Louis), the Western Power Corporation (California) and the Mississippi River Power Corporation. The group constitutes the largest electric supply undertaking in the world under single ownership, and its annual gross revenue is over £17,000,000.

Mr. Sawyer is a graduate in electrical engineering of the university of Nebraska and thus he combines technical knowledge with the extensive experience of the financing and administration of large public utilities obtained from his business connections. He is a fellow of the American Institute of Electrical Engineers, a member of the National Electric Light Association and first vice-president of the American Railway Association.

In view of the magnitude of the task confronting him, Mr. Sawyer is bringing an engineering associate to assist in the inquiry. He has chosen for this position Mr. H. W. Eales, chief electrical engineer of the Union Electric Light and Power Co., St. Louis, who is a regional vice-president of the American Institute of Electrical Engineers, and has had considerable experience in the construction and operation of large power stations. The gentlemen will leave San Francisco for Australia on Feb. 2. It is estimated that the inquiry will cost about £6,000.

Energy Loss in Dielectrics—I.

By M. C. Timms¹

The introduction of loaded cables for telephony, the use of higher voltages for underground distribution of electrical energy, and the progress of radio engineering, have all tended to make the study of energy loss in dielectrics of first rate importance. It is intended in these notes to more particularly refer to losses in insulated cables; but the greater part of what follows can be applied with equal appropriateness to condensers as such. The following symbolism is used throughout the article:—

V = Difference of potential in volts (p.d.)
(r.m.s. when alternating).

I = Current in amperes.

R = Resistance in ohms.

G = Leakance in mhos.

K = Capacity (effective) in farads.

$\omega = 2\pi f$ when f = periods per second.

The effective capacity K is such that the charging current is given by $\omega.K.V$. Except when the dielectric loss is excessive K is sufficiently approximate to the true capacity to be regarded as such.

A great deal of work has been done with very little result in the endeavor to obtain a clear conception of what takes place when a slab of insulating material is subject to electric stress. A very large amount of useful information has, however, been gained, with the result that great improvements have been made in cable insulating materials. One essential difficulty in the study of dielectrics arises from the fact that, being all more or less natural organic products, no two samples taken behave exactly alike, with the consequence that very contradictory results are frequently obtained from the most carefully conducted experiments.

It is proposed in these notes to describe some of the work which has been done and to attempt to outline a general theory applicable to the behavior of dielectrics when subjected to either direct or alternating potential difference.

Nature of Losses

When an alternating e.m.f. is applied to a condenser or insulated cable, the current flowing will not usually be 90 deg. in advance of the voltage, but will have a phase displacement depending on the power factor of the dielectric. When air is the insulator, the power factor ($\cos \phi$) is zero, and the current and voltage are in quadrature; this is the criterion of a perfect condenser. In the case of a solid dielectric, however, the power factor is greater than zero, and the phase difference is less than 90 deg. The difference between the actual phase displacement and 90 deg. is called the Angle

of Loss, and is designated θ . The charging current is in this case made up of two components, one the true capacity current in quadrature with the voltage, and a comparatively small current in phase with the voltage. The latter current is thus an energy current, and gives rise to what are known as Dielectric Losses, which are dissipated mainly in heat. The loss current is the product of V and G, and can be regarded as leakage current through resistance $1/G = S$. The quantity G is designated leakance.

The Nature of Leakance

Little is at present known regarding the true nature of leakance. All the information so far available goes to show that leakance follows a law which is expressed in the terms $A + \omega.B$. The governing components are undoubtedly A and B, while there is some possibility that there are other factors such as corona or local ionisation, though the latter is negligible until a certain potential gradient is attained. The first component is of the nature of a pure resistance, subject to Ohm's law, and varying inversely with temperature. The second component is frequently regarded as a form of hysteresis, though Steinmetz² doubts whether there is any action in dielectrics subject to alternating stress analogous to magnetic hysteresis.

It has been noted already that leakance at any frequency is the reciprocal of insulation resistance, S, at that frequency. It must be remembered that S is very different to the steady current insulation resistance, M.³ It is sometimes stated that there is no connection whatever between the two. This statement is, in the opinion of the writer, far too sweeping, in view of the present lack of knowledge. Greater insight into the phenomenon of electrification or absorption will possibly lead to some reconciliation between M and S.

At ordinary air temperatures leakance in all substances is greatly dependent on frequency, that is, the component $\omega.B$ predominates. In the case of impregnated paper cables, and possibly those insulated with other materials $\omega.B$ is lowered in value by increase of temperature, and finally disappears. After this stage is reached G is no longer dependent on frequency, and leakance with either alternating or direct p.d. is the same. The critical temperature is said to be the melting point of the impregnating compound. This feature accounts for the peculiar relation between dielectric loss (watts) and

2. A.C. Phenomena. Ed. 5, p. 150.

3. See "Electrical Engineer," vol. 1. p. 453.

1. Siemens Bros. and Co. Ltd., Melbourne.

temperature in high voltage paper insulated cables, as shown in Fig. 4.

The value of G is only slightly sensitive to variations of voltage.

Electrification

When a battery with potential of several hundred volts is applied across the dielectric of a condenser or cable through a galvanometer, as in Fig. 1, by putting the key contact to the left, a momentary rush of current will ensue. This is proportional to the quantity (coulombs) required to charge the true capacity to the potential of the battery, and it will necessitate the short circuiting of the instrument. This initial transient current is utilised in the ballistic test for capacitance. If, after a few seconds, the short circuit key is opened, a current will

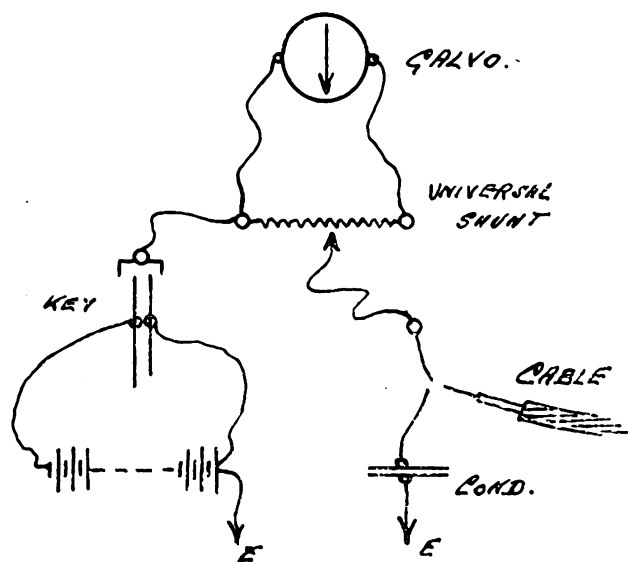


Fig. 1

still be found flowing. As time elapses, the value of this current will decrease more or less rapidly, depending on the nature of the dielectric. The smoothness of the progressive decrease is a proof of absence of flaws in the insulating wall, and the converse. The current observed is ordinarily regarded as wholly leakage current, and its value at 60 seconds is used as a basis for calculating the insulation resistance of commercial wires and cables. It is quite certain, however, that as a criterion of the value of a cable, the figure so obtained is of exceedingly little value, except in a comparative sense.

The application of the battery until the reading becomes stationary may occupy an hour or more, and the value of insulation calculated from such steady reading, can be regarded as the true resistance to a direct current.

If, after application of the battery as described above, the cable be discharged, by putting the key to the right hand contact, a current in the reverse direction to the apparent leakage current

already observed will continue to flow from the cable for a considerable interval. Readings of this current will, when plotted, produce a curve similar to, but reversed from, that given by the battery reading. These earthed readings are the draining out of the absorbed charge.

Assuming the cable discharged by a momentary contact of the key to the right, and then remaining insulated by the key being put central, after an interval, the cable will be found to be again charged to a potential approaching that of the battery. Thus the absorbed charge drains out, and being unable to flow to earth, charges up the true capacity of the condenser to an appreciable potential.

Fig. 2 shows current readings plotted against time during the electrification period of five minutes, and the earth reading period following. It will be noticed that if the last battery reading be added to the first minute earth reading, the result approximately equals the first minute

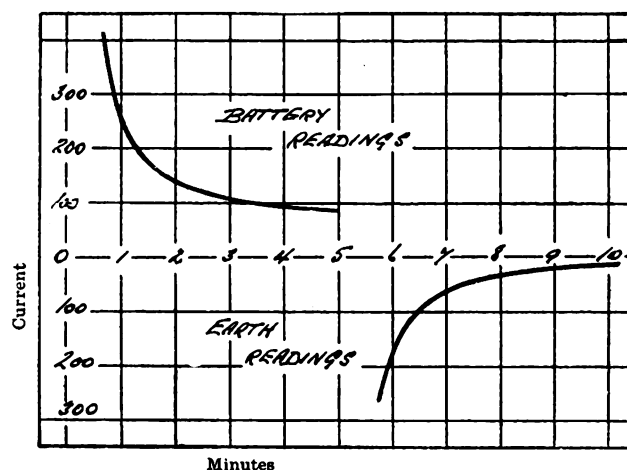


Fig. 2

battery reading, and similarly each earth reading in succession, added to the last battery reading, approximates in turn the second, third, etc., battery reading.

Theory of Electrification

It may be noted that electrification, or absorption, is confined to solid dielectrics, and is quite absent in gases, such as air. On this fact the theory of electrification, due to Maxwell, is largely founded. It is assumed that owing to the lack of homogeneity common to solid substances the electrical structure of such is somewhat as represented in Fig. 3, which depicts a combination of resistances and capacities.

Assume a steady p.d. applied across XY, the opposite surfaces of a layer of dielectric. A first rush of current will charge the true capacity C . In a homogeneous dielectric the consequent current will be that flowing through the very high true insulation resistance R . There are, however, in solid substances, internal

capacities c c , etc., connected to X and Y by high resistances r r , etc. Owing to their being in series with r r , etc., the capacities c c , etc., are only charged up gradually, their charging current giving rise to the progressively decreasing current, noted in part 1 of Fig. 2. When c c , etc., are fully charged, the only current flowing is that through R , which is that indicated when the graph becomes parallel to the line of abscissæ.

If when the p.d. is removed X and Y are joined together through a negligible resistance, C immediately discharges, and the momentary current is followed by a gradually decreasing

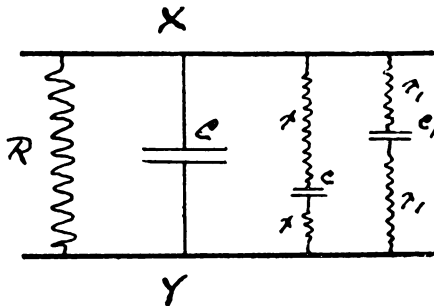


Fig. 3

current as c c , etc., slowly discharge through their series resistances, giving the earth readings, shown in the second portion of Fig. 2.

If when the p.d. is removed, X and Y are momentarily put together, and then separated, C , having been discharged, will be gradually re-charged by c c , etc., through r r , etc. For this reason condensers or cables, which have been subjected to a prolonged application of a high direct voltage, should be kept permanently earthed for a considerable period, before regarded as discharged.

For transient or alternating p.d.'s C has most significance. The inherent difficulty in measuring C of a long submarine cable arises from the fact that, owing to the conductor resistance, C takes time to charge and discharge and so gives time for c c , etc., through r r , etc., to become included in the result. With an alternating p.d. of high frequency, say 800 p.p.s., C only comes fully into action, the p.d. not remaining at one value sufficiently long for c c , etc., to become fully effective. For this reason there is a slight discrepancy between capacity measured at 800 p.p.s. and as measured by the ballistic test, because no matter how quickly the latter is carried out c c , etc., have more time to contribute to the result than when high frequency p.d. is used. If the ballistic test is made with suitable precautions the discrepancy is negligible.

Effect of Alternating P.D.

Consideration of Fig. 3 and the remarks in the preceding section will disclose that however long the steady p.d. is applied the only energy

loss is that through the exceedingly high resistance R . If the material is an insulator at all this loss will be infinitesimal at ordinary temperatures. When an alternating p.d. is applied to X - Y a quite different state of affairs will become apparent.

Under alternating conditions the condenser C will take a current which is purely displacement and in quadrature with the p.d. A current will also pass through R which will be in phase with the p.d. and will cause small energy loss at low temperatures. The condensers c c , etc., will be charged through resistances r r , etc., giving rise to currents i i , etc., and so causing expenditure of energy proportional to $i^2 r$ $i^2 r$, etc.

The two losses here referred to combine to form the loss due to leakance. The first loss is due to the resistance component and the second to the so-called hysteresis. The second loss will depend on frequency, because i i , etc., are proportional to the p.p.s. of the p.d., whereas the first loss will be independent of this factor.

Effect of Temperature

Assuming the alternating case and again referring to Fig. 3. The effect of increase of temperature will be to lower the value of r r , etc., and as the value of i i , etc., is governed by c c , etc., the values of $i^2 r$ $i^2 r$, etc., will be lowered, showing decreased loss. Thus as stated earlier the "hysteresis" loss is inversely affected by temperature. At the same time the value of R will be rapidly reduced by progressive increase of temperature, resulting in higher leakage currents and correspondingly greater energy loss, until the resistance loss which originally was negligible becomes the predominant factor, the hysteresis element having meanwhile become of progressively less importance.

The effect of temperature change on the energy loss in impregnated paper cable insulation is shown in Fig. 4. In the earlier stages, when the loss is controlled by hysteresis ($i^2 r$ $i^2 r$ etc.), the amount of loss falls off rapidly as temperature increases until the point when resistance loss takes charge, when the process is reversed.

Significance of G/K

For a given material the ratio G/K is a constant when G and K are respectively the leakance and the capacitance of a slab of the particular material separating two conducting surfaces.⁴ The value of this constant is of very great importance in loaded telephone cables, that is those to which inductance has been artificially added. Reference to formula (5)⁵ discloses that more especially when L is large it is important that G/K be kept small in order that the full benefit of loading may be felt.

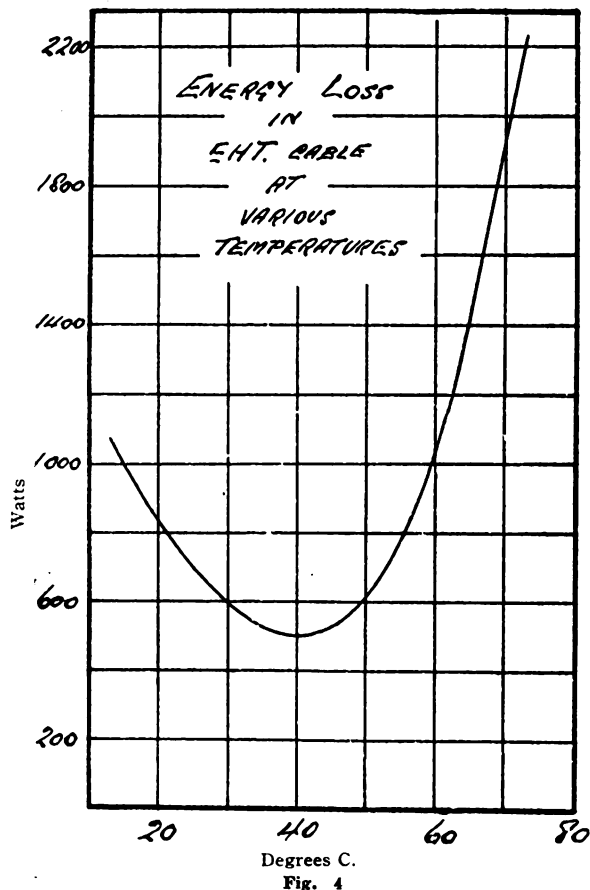
4. "Electrical Engineer," vol. 1, p. 453.

5. "Electrical Engineer," vol. 1, p. 455.

For this reason measurements of G/K are among the most important of those required in connection with telephonic transmission.

Measurement of G/K

The most convenient and generally used method of obtaining the value of this constant is by the Wien bridge as described by A. Campbell.⁶ This arrangement is shown diagrammatically in Fig. 5. A. and B are fixed non-inductive resistances, C is an adjustable condenser having negligible loss angle, Q is an adjustable non-inductive resistance, T is a detecting device such



as a tuned telephone or vibration galvanometer. A source of alternating e.m.f. of suitable constant frequency is connected in place of the battery in the ordinary resistance bridge. The fourth arm of the bridge is composed of the imperfect condenser having capacity K shunted by resistance S.

A and B having been fixed at convenient values the bridge is balanced by adjusting C and Q. Then

$$K = \frac{B}{A} \frac{C}{1 + \omega^2 C^2 Q^2} \quad (1)$$

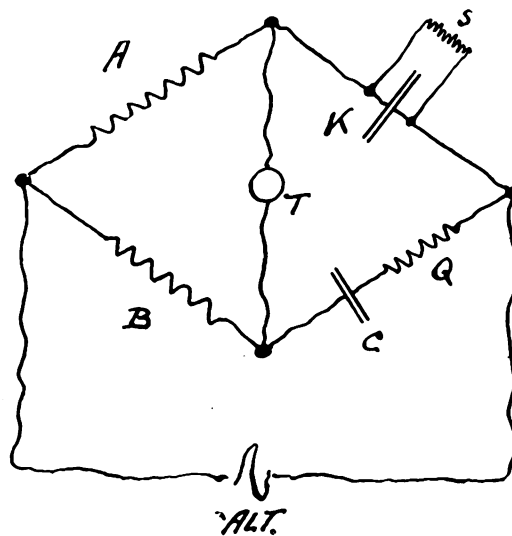
$$S = \frac{A}{B} \frac{1 + \omega^2 C^2 Q^2}{\omega^2 C^2 Q} \quad (2)$$

$$G/K = \omega^2 C.Q \quad (3)$$

$$\tan. \theta = \omega .C.Q. \quad (4)$$

Possible sources of error are slight residual inductance and capacity in A, B and Q. Also if C is not an air condenser it will have a slight loss angle. Resistances can readily be made so nearly non-inductive that errors from this cause are negligible. Loss angle in the standard condenser is readily allowed for if of sufficient magnitude to affect the result.

An extremely useful refinement to the Wien bridge is the Wagner earth connection. In order to eliminate static disturbances, which interfere with the accuracy of balance some point on



the bridge should be connected to earth. The precise point depends on the adjustment of the bridge and can be found by means of the auxiliary circuit comprised of A, C, Q, with T, and switch P shown in Fig. 6.

To use the Wagner connection a preliminary balance on T is obtained, the switch P is then closed and by adjusting A, C, and Q, a balance is obtained on T. A further balance is now obtained on T with P open. Each bridge is balanced in turn until neither affects the other. Usually two adjustments of each are all that is required, assuming the values of C and Q are known approximately at the commencement of the test.

Further Significance of G/K

As already noted the dielectric loss current is the product of V and G. Therefore the watts lost are

$$W = V^2 G \quad (5)$$

$$\text{or } W = V^2 \frac{G}{K} .K \quad (6)$$

These equations are correct for any voltage provided the measurements of G/K are made at the exact frequency and nearly the voltage in question. The ratio G/K is thus of equal importance at low frequencies and high voltages, as under telephonic conditions, and a knowledge of its value will lead to a knowledge of the watts lost in a high voltage transmission cable dielectric. This fact serves to emphasise the essential unity of all electric phenomena, which is too seldom realised.

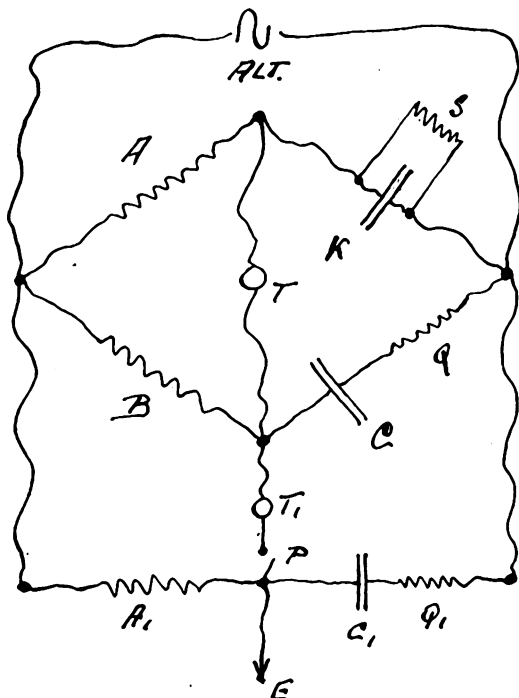


Fig. 6

Dielectric Losses at High Voltage

It is seen from formula (4) that dielectric losses are proportional to the square of the voltage. Thus a loss of energy which will have insignificant effect at 11,000 volts may be appreciable at 22,000 volts, being four times as great. Fig. 4 also shows that the watts lost increase rapidly after a temperature of 50 deg. C. is exceeded. The energy expended in the dielectric is almost all converted into heat, raising the temperature of the cable and reducing the margin of safe temperature. Such a process limits the allowable I^2R loss in the conductors, and hence the carrying capacity of the cable. For these reasons cables for working pressures of 20,000 volts and over are regularly tested for dielectric losses, and a maximum figure is frequently guaranteed by the manufacturer.

The measurement of dielectric losses at high voltages, having become an important item in the manufacture of cables, accurate methods of

testing readily applicable are of special importance. In order to provide some check on dielectric losses specifications for 33,000-volt cables have required that the conductor resistance be measured before and after voltage test. The two tests should indicate no appreciable rise of temperature of the copper. This device is really futile because, under the worst conditions likely to be found, the energy liberated, if all consumed in heating the conductor, would not raise the resistance of same appreciably. There are two reasons for this: the high specific heat of copper and the low temperature coefficient.

A more effective check of dielectric losses is to measure the insulation resistance immediately before and after the voltage test. An appreciable fall of resistance can often be detected, partly because the temperature coefficient of dielectrics is high and the specific heat small. Such devices are, however, no more than an indication.

Energy losses in insulating materials have been investigated by Rayner using the quadrant electrometer as a watt meter.⁷ This device is open to several objections more especially when the object under test has considerable capacitance.

The Duddell-Mather wattmeter can be used for power measurements at very low power factors. But any wattmeter method is open to the objection that it is sensitive to slight changes of voltage, and errors in the voltmeter are thus of special importance. The values of G and K are not, however, very sensitive to voltage variation, and they can be taken as accurate indications of dielectric loss so long as the test voltage approximates the required value.

For these reasons some process by which G and K can be accurately measured and the energy loss calculated by formula (6) is preferable to the use of a wattmeter. Hence the Wien bridge can be applied to high voltage cables with advantage, and it has in addition the well-known superior accuracy of null over indication methods.

In view of the considerations set out, the Wien bridge specially arranged has been adopted for testing at high voltage in the cable works of Messrs. Siemens Bros. and Co. Ltd. The method of application together with a general discussion of the Wien bridge was given in detail in a paper to the Physical Society in 1923 by Mr. A. Rosen. To this publication the reader is referred for details. An outline only of the ingenious adaptation of the Wien bridge and Wagner earth device, by which the losses in any region of a three-core cable can be isolated and measured, will be given.

(To be concluded)

⁷ I.E.E. Journal, V. 49, p. 3, 1912.

White Way Lighting in St. Kilda Road, Melbourne

The Melbourne city council has recently put into operation the first section of its new lighting installation on St. Kilda road, and the result gives every satisfaction. The scheme was briefly outlined in these columns some months ago. The thoroughfare is acknowledged to be one of the finest in the world. It has a 66-ft. central roadway carrying tram tracks (which are at present being converted from cable to electric traction), and two side motor tracks, each 30 ft. wide, divided from the centre road by plantations. The whole is flanked by 18-ft. asphalt pavements. On each plantation and along the

waste of light by re-directing the rays as required; at the same time the diffusing glass panels break up the beams, giving a soft light without any glare whatsoever. The design of the unit and standard is very artistic and pleasing to the eye, so that the installation is ornamental by day as well as being efficient by night.

There are four rows of the light standards: one on the inner edge of each plantation for lighting the centre road, with spacing of 240 ft. between units, and one on the outer edge of each plantation for lighting the motor tracks and pavements, with spacing of 120 ft. between units. The centre rows have 300 watt lamps and the outer rows 200 watt. As the plantations are not very wide a good deal of light from the outer units is thrown on to the centre

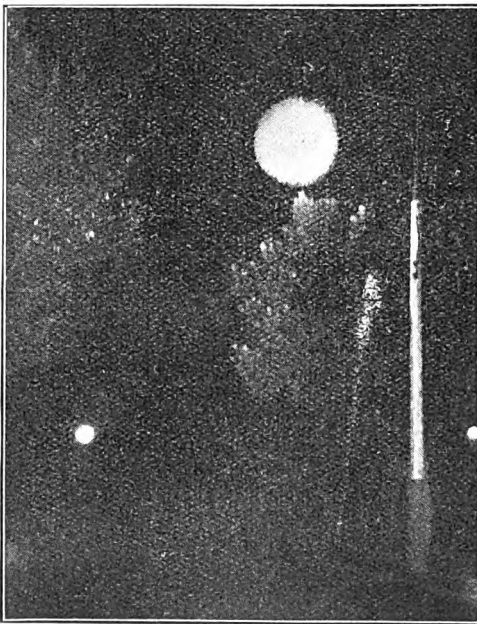


Fig. 1. St. Kilda Road, Melbourne: Old Lighting with Arc Lamps

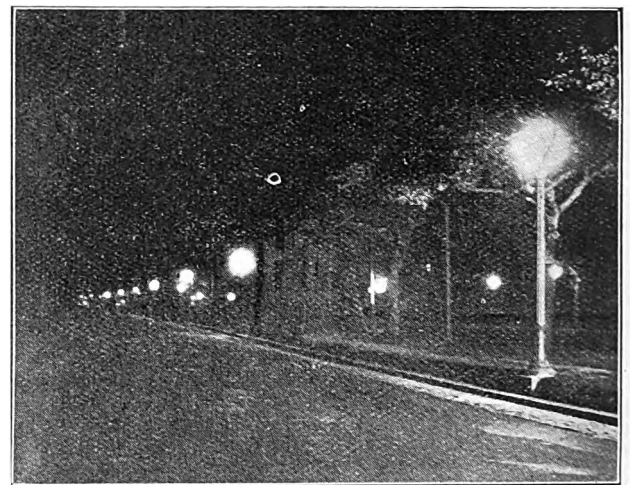
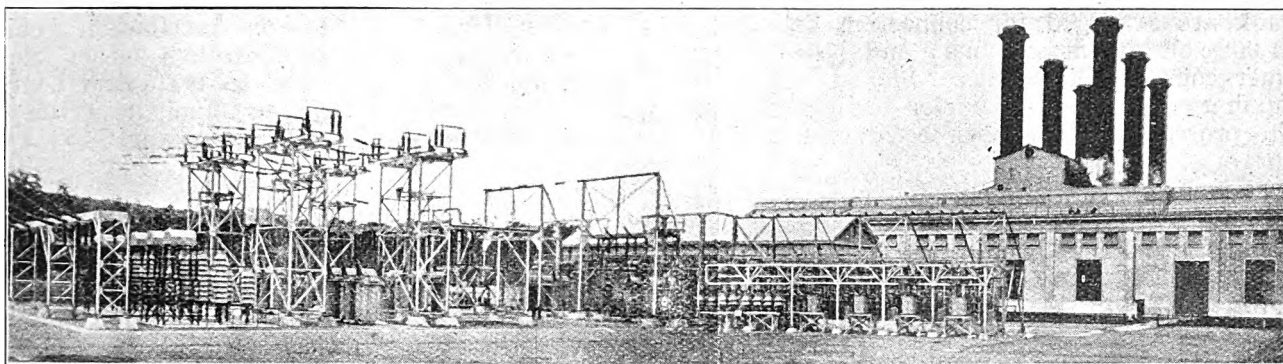


Fig. 2. St. Kilda Road, Melbourne: New Lighting Installation with G.E. Novalux Units.

edge of each pavement there is a row of deciduous shade trees, and in addition the plantations carry numerous ornamental shrubs and grass plots. Such a highway demands the best in lighting, and the new installation is certainly well up to the standard set by the situation. G.E. Novalux lighting units are used, supported on pressed steel standards of such height that the lamp centre is 13 ft. above the pavement. The unit consists of a metal framed lantern with eight panels of diffusing glass. The source of light is a 200 or 300 watt gas filled lamp, and the rays are efficiently directed by a Holo-phane dome refractor supported above the lamp, and a plain white enamelled conical reflector below. This arrangement effectively prevents

roadway and vice versa, consequently a high intensity of illumination and remarkably even lighting is obtained across the full width of the thoroughfare.

In addition to installing this system on St. Kilda road the council is taking steps to provide better lighting for Princes bridge, which is the connecting link between St. Kilda road and the city. A scheme has been designed which will harmonise with the installation just described. Novalux units of the same type are to be used, mounted in pairs on ornamental cast iron standards attached at intervals along the parapet of the bridge. It is confidently expected that this lighting system on road and bridge will make the southern entrance to the city as beautiful by night as it is by day.



Yallourn Power Station: Switchyard.

Electrical Equipment of the Yallourn Power Station—I.

The Yallourn power station of the Victorian electricity commission has an installed capacity of 62,500 kw. in five generating units. There are 12 John Thompson boilers, of 70,000 lb. per hour evaporative capacity each, burning brown coal exclusively. Steam is supplied to the turbines at a pressure of 250 lb. per sq. in. above atmosphere, superheated to a temperature of 630 deg. F. The turbines are of the impulse (Rateau) type, running at 3,000 r.p.m. and exhausting to surface condensers. The turbo-alternators, condensers and all engine room auxiliaries were supplied by the Metropolitan-Vickers Electrical Co. Ltd., of England. Messrs. Thompson and Co. (Castlemaine) Pty. Ltd., Victoria, were sub-contractors for the construction of the condensers and circulating pumps. In addition to the main generating sets there is a 600 kw., non-condensing house turbo-alternator set, which also was supplied by the Metropolitan-Vickers Electrical Co. Ltd.

The main generators are of 12,500 kw. (13,900 kv.a.) capacity each and generate at 11,000 volts, three phase, 50 cycles. As the machines run at 3,000 r.p.m. they are, of course, bipolar. Each has its own direct-connected exciter of 25.6 kw. capacity (160 volts, 160 amps), with radial commutator. The alternators are ventilated on the closed circuit system, each drawing in air by means of fans attached to the rotor. The air circulation is assisted by an external fan driven by an 85 h.p. motor. After passing through the machine the air is brought down in temperature in a cooler consisting of finned water tubes. The air temperature is continuously indicated by a dial thermometer mounted on a pedestal near the machine. Should it rise above a predetermined figure a contact is made which lights a red lamp and sounds a warning hooter.

Supply to Auxiliaries

The turbine room auxiliaries are all electrically driven. Control of the motors is effected by the agency of automatic contactors energised from push buttons located near the machines. The method of starting varies with the different motors: the 260 h.p. circulating pump motors are started by means of rotor resistances; the 66 h.p. extraction pump motors are started by compensators; star-delta starting is employed for the 85 h.p. fan motors; the small valve-operating motors are thrown directly on the line. Under normal conditions the supply for the auxiliaries is obtained from the main generators through auxiliary transformers and unit auxiliary switchboards. Oil circuit breakers control the feeders supplying the large motors, and air breakers or knife switches are used for the small motor circuits. All the feeders are provided with protective relays.

The general arrangement of the auxiliary supply will be understood from reference to the single line diagram of the station, Fig. 1. There are three banks of auxiliary transformers, each consisting of three 500 kv.a. single phase units, stepping down from 11,000 to 400/230 volts. The 400-volt leads are connected to stub buses from which feeders are taken to the unit auxiliary boards. Under normal conditions the h.t. side of each transformer bank is supplied from the generator tie bus, but supply may also be given from the transfer bus. Each 400-volt stub bus may, if necessary, be connected to a 400-volt emergency auxiliary bus, which latter is normally kept alive by a spare auxiliary transformer bank. Alternatively this emergency auxiliary bus may be energised by the house turbo transformer bank acting as a step-down, or by the house turbo-alternator set. The house turbo bank is composed of three 250 kv.a. single

phase units. Both this and the spare auxiliary bank are arranged for connection between the 11,000-volt transfer bus and the 400-volt emergency auxiliary bus. Should one of the auxiliary transformer banks become defective, the protective relays open both its h.t. and l.t.

A feeder runs from the 400-volt emergency auxiliary bus to a 400-volt distribution board in the control building. Another feeder runs from the house turbo bus to the same board. From the distribution board supply is given to a battery-charging motor-generator, to two

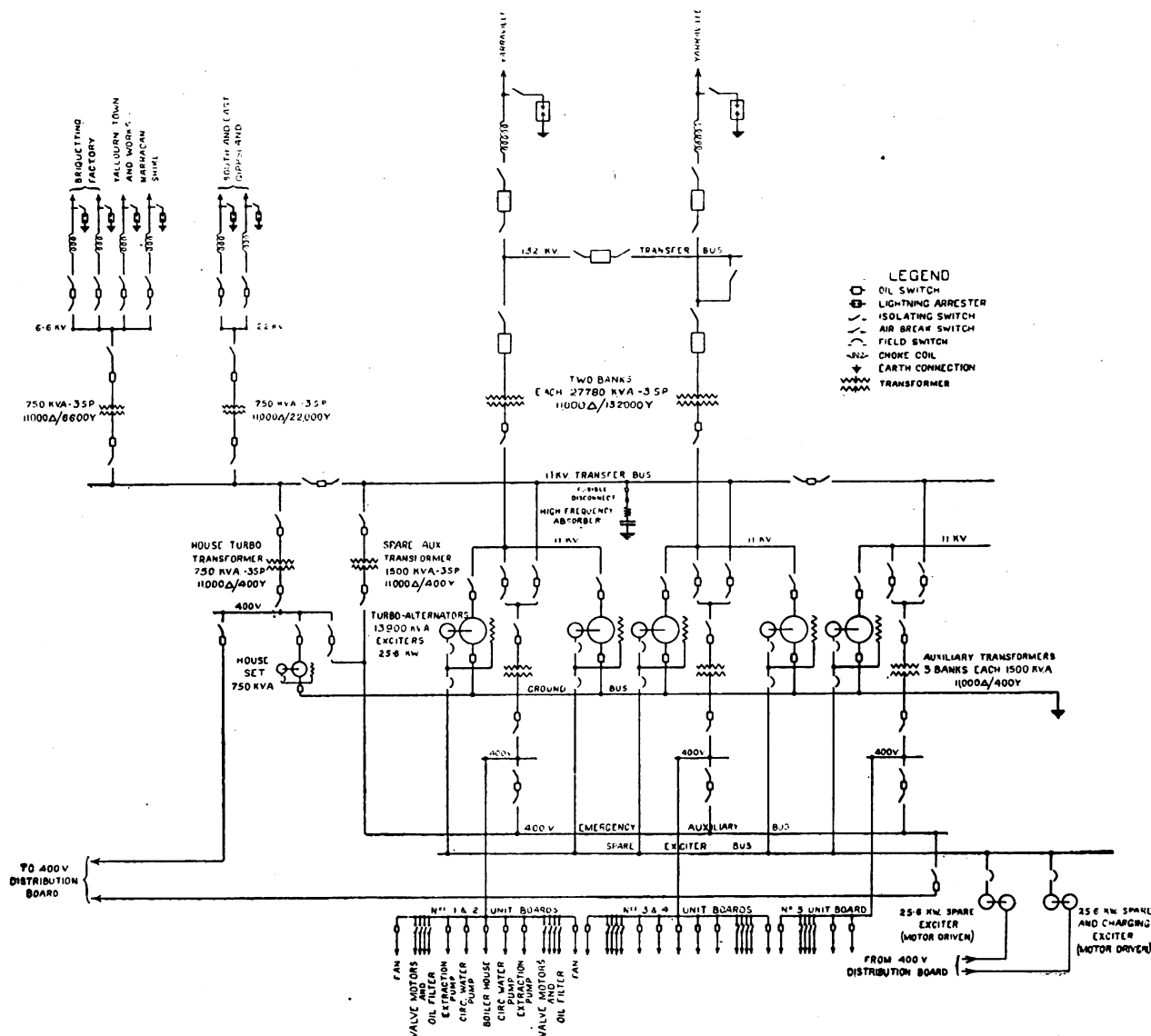


Fig. 1. Single Line Diagram of Power Station Connections

circuit breakers, and at the same time close the breaker connecting its stub bus to the emergency auxiliary bus. The power station auxiliaries which were being supplied by the defective bank are then fed temporarily by the spare auxiliary transformer, then change-over being so rapid that no check in the running is experienced. Should the spare bank be defective the house turbo bank is available to take up the running or, as a last resort, the house turbo-alternator may be run up to give supply.

motor-driven exciters, and for the lighting of the power station, workshops, and administrative building.

House Set

The house turbo-alternator set is of 600 kw. capacity and generates at 400 volts, three phase, 50 cycles. In the case of a complete shut down of plant it will furnish energy for starting up the station auxiliaries. It runs in conjunction with the house turbo transformer bank which steps up the energy to 11,000 volts. In starting

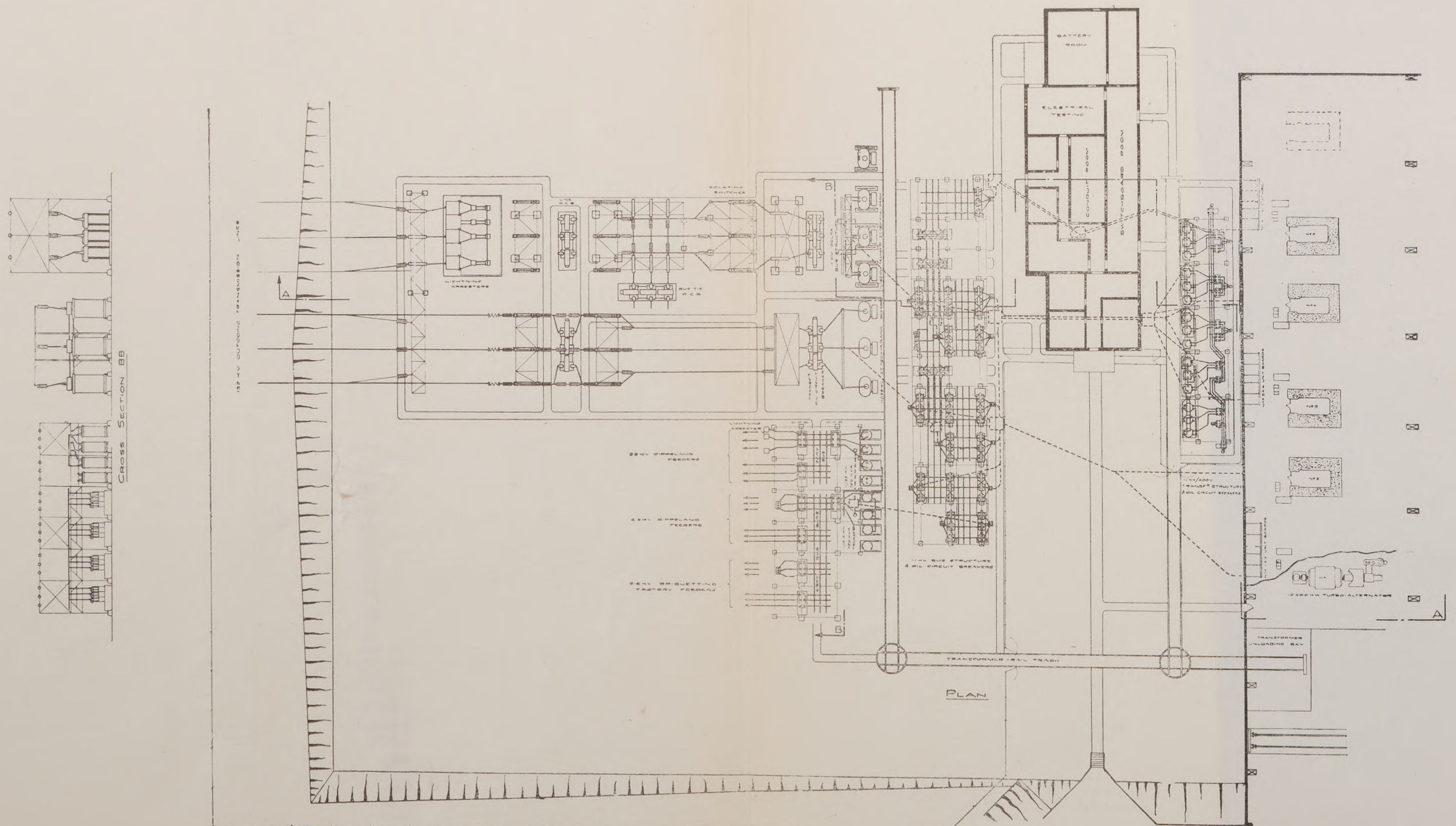
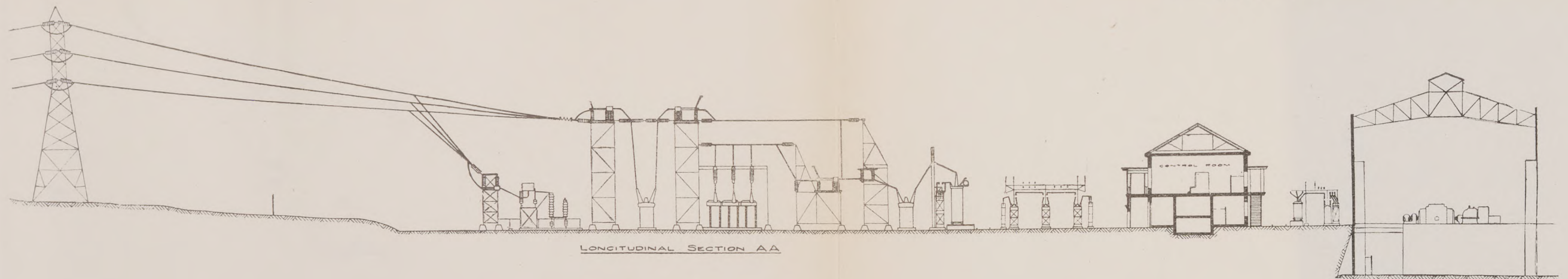


Fig. 3.—Yallourn Power Station: General Arrangement of Main Switchgear

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up the plant the 11,000 volt transfer bus is energised through this transformer. When one of the main sets has been run up to speed it is synchronised with the house set on this bus, thus enabling the auxiliaries to be changed over from the house set. The latter is then shut down.

Excitation

The excitation system of the main generator is designed to make adequate provision against the possibility of breakdown of any of the

rheostat of the main exciter in the spare exciter field so that the Tirrill regulator will be transferred to the spare exciter. A rheostat transfer bus is used in conjunction with contactors for effecting the change.

The charging exciter is a specially designed machine for supplying the very small excitation required by any one of the main generators when supplying leading current for charging the main transmission line. The magnetising effect of this leading current on the field of the

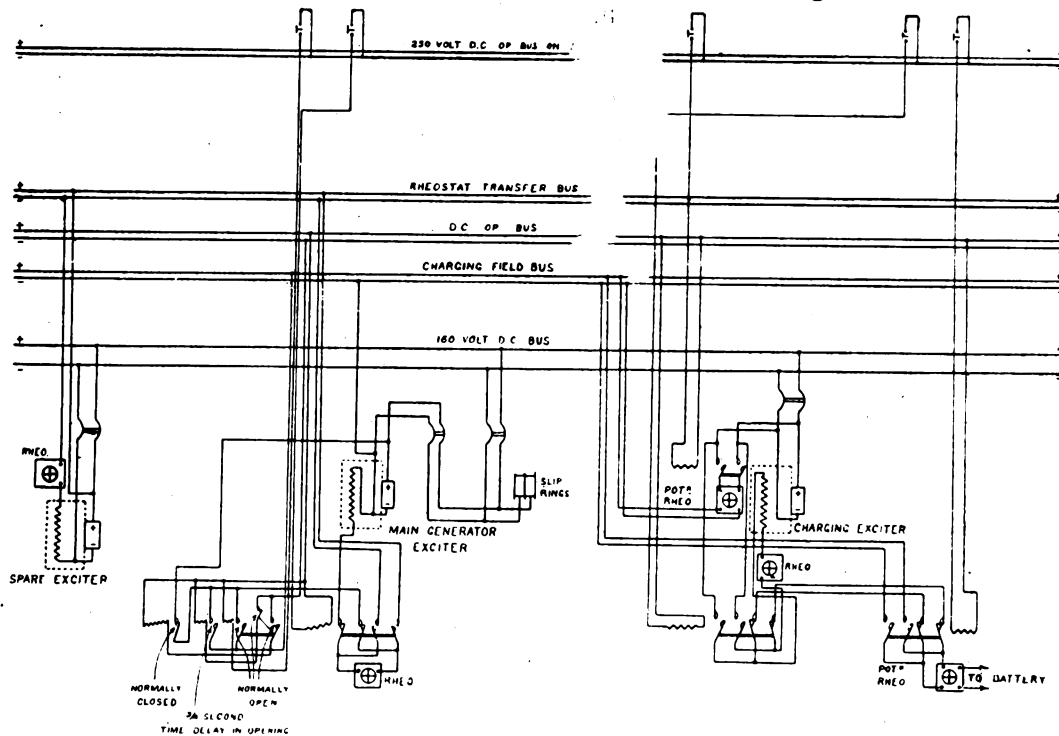


Fig. 2. Excitation Diagram

exciters. As has been stated, each turbo-alternator has its own direct-connected exciter of 25.6 kw. capacity. In addition, there is a motor driven spare exciter which can be used to replace any of the main exciters. There is also a motor driven charging exciter, furnished for use in the operation of charging the main transmission lines, which can be utilised as a spare if the necessity arises. These machines are all controlled through a field and exciter switchboard situated in the turbine room basement. The connections of the excitation system are shown in Fig. 2. The field and exciter board accommodates electrically operated air circuit breakers, which serve as field switches, and numerous contactors for changing over the exciter leads. Voltage control of each main generator is effected by means of a series rheostat in the exciter field. Constant voltage is maintained by the aid of a Tirrill regulator. When the spare exciter is being used in place of one of the main exciters it is necessary to use the

main generator is such that only a very small field current is required from the exciter. Indeed, in designing the plant consideration was given to the possibility of requiring reversed excitation in order to preserve stability of operation in the main generator. The field of the charging exciter is wound, like those of the other exciters, for shunt connection, but it may be separately excited from a battery through a potentiometer rheostat if desired. The exciter energises a charging field bus from which the generator field is fed. In order to permit of still finer grading of the voltage impressed on the main generator field than is obtainable from the exciter field rheostat, a second potentiometer rheostat is introduced between the exciter and the bus.

As an alternative method of exciting the main generator during line charging the generator's own exciter may be used, with its field energised from the charging field bus. The bus may be energised either from the charging exciter, as described above, or

from the battery, through the potentiometer rheostat alone. All these various connections are made by means of contactors mounted on the field and exciter board. If it is desired to use the charging exciter merely as a spare it is connected, by means of a circuit breaker, to another field bus which is normally fed by the spare exciter. All the rheostats in connection with the excitation system are located at the back of the field and exciter board and are motor operated. Control of the rheostats and contactors is effected by means of switches mounted on the main bench board in the control room.

also of outdoor construction. The 400-volt distribution boards, however, are all of the indoor type. The whole of the outdoor switchgear, with the exception of certain hand-operated isolaters, is operated by remote electrical control from a switchboard situated in a control building.

The control building, with which the administrative offices of the station are incorporated, is situated with its length parallel to that of the turbine room. Immediately in front of the building is the 11 kv. bus structure which carries the generator buses and transfer bus, with dis-

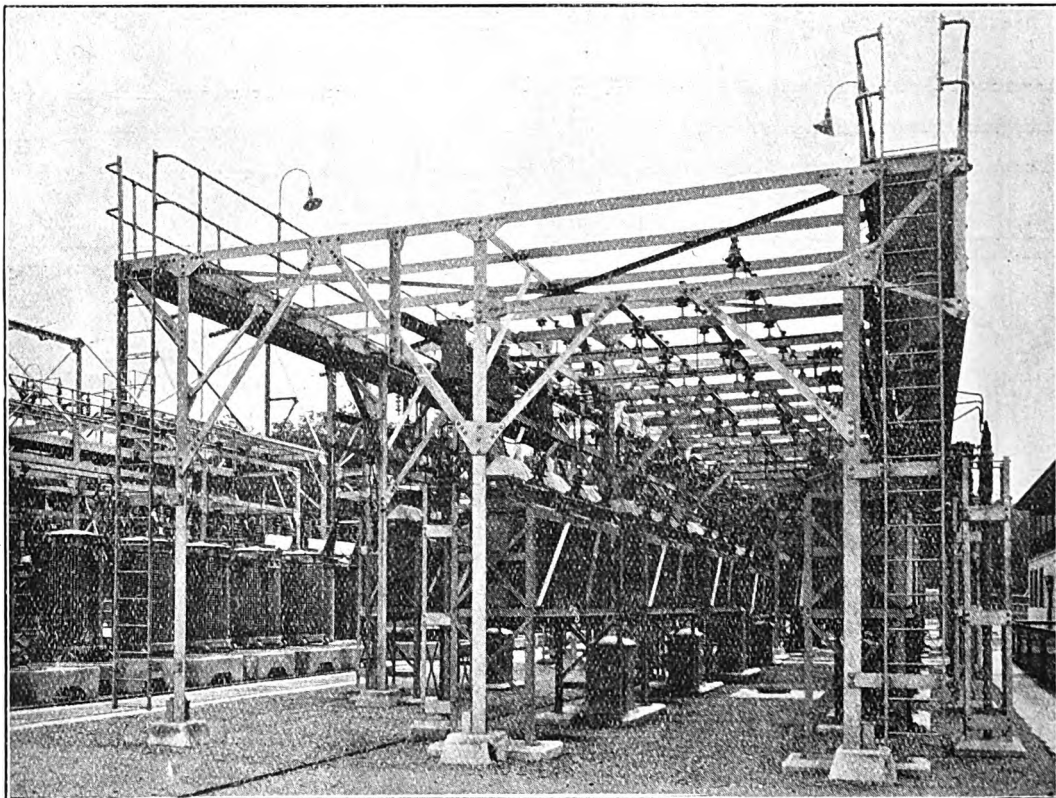


Fig. 4. 11 kv. Bus Structure: Southern End

Switchyard and Equipment

The whole of the main switching and transformer equipment of the station is of outdoor construction, located in a switchyard on the west side of the turbine room. The general layout of the yard is shown in Fig. 3. The principal function of the installation is that of supplying energy to Melbourne over a 132 kv. two-circuit transmission line, but smaller amounts of power are taken at 22 and 6.6 kv. for distribution in the province of Gippsland and for local requirements on the Yallourn works.

The 11,000/400 volt transformers for auxiliary supply, together with the stub buses and emergency auxiliary bus and switchgear, are

connecting switches and current and potential transformers. The main transformer banks are situated opposite the middle of the 11 kv. structure, and beyond the transformers are the structures carrying the 132 kv. busbars, motor-operated disconnecting switches, etc. The structure carrying the 22 kv. and 6.6 kv. busbars is located opposite the left hand or southern end of the 11 kv. structure. The transformer banks for stepping from 11 kv. to 22 kv. and 6.6 kv. respectively are situated between these structures but nearest to that carrying the secondary voltages. From the 22 and 6.6 kv. busbars transmission lines radiating to various loading centres are fed. The 400-volt structure

is situated between the control room and the turbine room, with the 11,000/400 volt transformers between the structure and the control room. From the 400-volt busbars the supply is taken by underground cables to the various distribution boards. Fig. 4 shows portion of the 11 kv. bus structure. The control building appears on the right, and some of the 6.6 and 22 kv. transformers are seen on the left.

All the switchgear structures, which carry the busbars, disconnects, instrument transformers, etc., are built of galvanised steel sections erected on concrete piers. The transformers are mounted on concrete foundations, as also are the 132 kv. circuit breakers. The 22 kv., 11 kv., and 6.6 kv. circuit breakers are mounted each on its own framework, fabricated of iron piping or angle iron, and are situated beneath the busbar structures. The 400-volt circuit breakers are mounted in sheet steel housings on concrete foundations beneath the 400-volt bus structure.

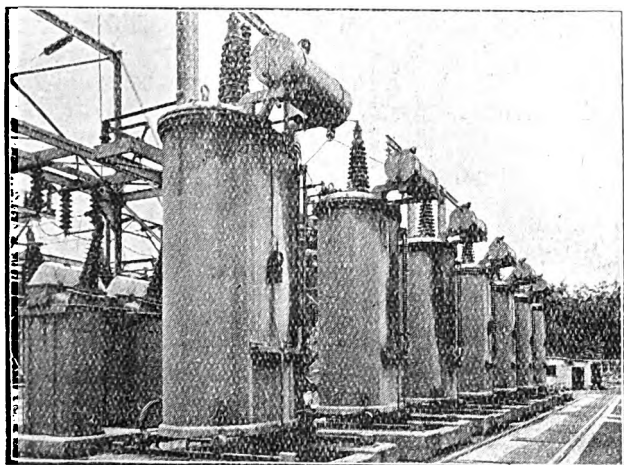


Fig. 5. Main 132 kv. Transformers

The general view of the switchyard at the head of this article shows the 132 kv. structures on the left and the 22 and 6.6 kv. structures on the right. The transformers and the whole of the switch and control gear were supplied by the General Electric Co. of America.

The main supply is stepped up to 132 kv. by two transformer banks each consisting of three 9,260 kv.a. single phase transformers connected 11 kv. delta/132 kv. star (Fig. 5). A seventh similar single phase unit is kept as a spare. From the single line diagram, Fig. 1, it will be seen that generators Nos. 1 to 4 are connected in pairs and each pair, together with one main transformer bank and one auxiliary transformer bank, form a unit supplying a single circuit of the outgoing 132 kv. transmission line. Under the present conditions No. 5 generator is kept as a spare but, by means of the transfer bus, it may be linked up with any other generator to form a unit. When both generators of a pair

are running they must of necessity be in parallel, but they are not necessarily paralleled with the generators of the other pair at the generating end of the transmission lines. By the agency of the transfer bus, however, it is possible to parallel all the generators when required. Nos. 1 and 2 generators normally supply No. 1 transformer bank, and Nos. 3 and 4 supply No. 2 bank. By means of the transfer bus, however, Nos. 1 and 2 can be made to feed No. 2 bank or Nos. 3 and 4 to feed No. 1 bank. The two outgoing 132 kv. lines may be paralleled through an oil circuit breaker and disconnecting switches, but when either line is being used by itself it can be supplied from either transformer bank. Thus, although normally the apparatus is divided into two self-contained units, the switching arrangements are such that several combinations of machines, transformers and lines can be obtained in order to tide over emergency conditions.

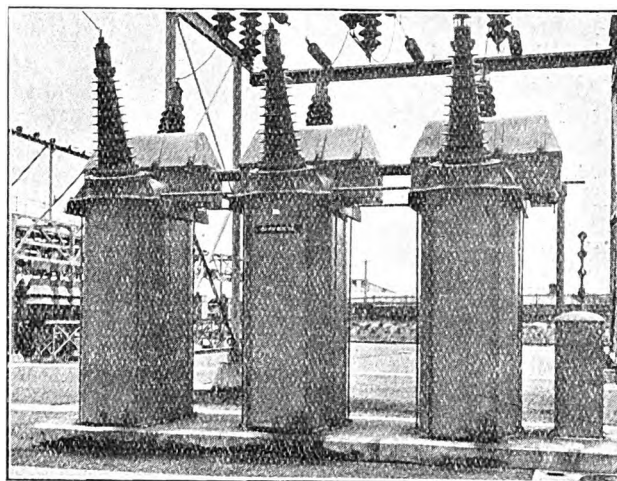


Fig. 6. 132 kv. Circuit Breaker

Each unit of the main transformer banks is mounted on a truck with flanged wheels so that it may be wheeled on to a transporter which runs on railway tracks communicating with the unloading bay in the turbine room. Water cooling is employed, the circulating water being pumped from the Latrobe river. Each tank is equipped with an oil conservator to which is fitted an oil gauge. In order to guard against unduly high temperatures each unit is provided with a capillary tube dial thermometer with the bulb located in the hottest oil. The dial is fixed to the side of the tank and is fitted with an alarm attachment by means of which a bell is rung in the control room when the oil temperature reaches a predetermined figure. In addition there is a temperature coil embedded in the low tension winding with leads brought out to a temperature indicating device located in the control room.

The supplies to the 22 kv. and 6.6 kv. structures are taken from the 11 kv. transfer bus

through 750 kv.a. transformer banks. Each structure mounts busbars, isolating switches and choke coils, and the oil circuit breakers and lightning arresters are mounted beneath. From the 22 kv. structure two outgoing lines feed to a switching station at Morwell, six miles distant, whence lines run to south and east Gippsland. The 6.6 kv. structure feeds four lines—two to the briquetting factory, one supplying the Yallourn works and town, and one feeding country towns in the shire of Narracan to the west of Yallourn. The transformers are self cooled, and each unit is equipped with a temperature coil. A spare unit is provided for each bank.

The auxiliary transformer banks are mounted beside the 400-volt bus structure. They are water cooled like the main transformers. A single spare unit is provided for all banks. The house turbo transformer bank also is located beside the 400-volt structure. The units in this case are self cooled, and a single spare is provided.

All the high voltage circuit breakers throughout the installation are triple pole single throw type, arranged for either solenoid or manual operation. They are of unit construction, each unit consisting of a tank, two bushings, two sets of contacts and a movable contact blade with operating rod and mechanism. The fixed contacts are attached to the bottom ends of the bushings. For the higher rupturing capacity switches plunger contacts with explosion chambers are used, but for those of less breaking capacity blade contacts with flexible fingers are sufficient. One solenoid operates the three units simultaneously. Fig. 6 shows one of the 132 kv. breakers. These breakers are all rated at 135 kv., 400 amps, and are capable of rupturing 840,000 kv.a. The 11 kv. generator circuit breakers are rated at 15 kv., 800 amps, and have a rupturing capacity of 400,000 kv.a. Some of the other 11 kv. breakers have rupturing capacities as high as 760,000 kv.a.

All the circuit breakers are electrically operated by pull button switches situated on a main bench board in the control room. The operating energy is supplied by a 250-volt lead storage battery. The current required for closing varies, according to the size of the breaker, from 50 to 120 amps. Currents of such order are too heavy for the control switches, therefore closing relays, actuated by small currents passing through the control switches, are used. The tripping current, however, is only about 2½ amps, and this the control switches are quite capable of handling without the intervention of relays. Special interlocking of control circuits is used with certain of the breakers. For instance, the closing circuits of breakers that must not be closed unless their respective gener-

ators are in synchronism are wired through the synchronising plug on the bench board, so that the breakers cannot be closed unless the synchroscope is in circuit.

Indication of the position of each breaker is given by pairs of colored lights on the board and on the breaker. A red lamp glows when the breaker is closed and a green lamp when it is open. These lamps are thrown into and out of circuit by means of auxiliary switches mounted on the circuit breaker structure and operated by the breaker mechanism. In order to ensure safety to anyone having occasion to carry out work on a circuit breaker, a two-way safety switch is provided beside each breaker. The closing circuit is wired through this switch so that when the safety switch is open the circuit breaker cannot be closed from the control room. When the safety switch opens the closing circuit it completes another circuit which causes a white lamp to glow to indicate that the circuit breaker is out of commission and cannot be closed. In the case of breakers that are equipped for automatic tripping by means of relays there is another white light mounted on the relay board in the control room. This glows when the breaker is closed but is dark when it is open.

(To be concluded)

SUCCESS OF NEW ZEALAND POWER BOARD SYSTEM

An electrical engineer of world-wide experience, who has been making a prolonged stay in New Zealand, stated recently that but for the power boards system the use of electricity could not possibly have progressed to the extent which it has done. He considers that similar developments would have been quite out of the question had the field been left only to private enterprise. Naturally, any commercial undertaking would pick the plums out of the country, and would leave the more sparsely populated districts entirely untouched. The power boards, having behind them their power to levy rates, if necessary, to carry over initial lean years, are able to take electricity supply into districts which would be hopeless to a commercial undertaking.

The technical control exercised by the government, by virtue of its license, has operated to secure uniformity of system and voltage, thus tending to keep down distribution costs. Such control, however, must not be carried too far for there is a danger that too much concentration will increase the total expenditure, without securing the best engineering practice in every case, simply because there is no close touch with local conditions. From a technical standpoint it would be better to give the boards greater freedom rather than increase restrictions.

Country Town Electric Supply in South Australia

The Undertaking of the Mid-North Electricity Co. Ltd.

Electricity supply has been making very rapid advances lately in South Australia, particularly in the country towns within about 100 miles of Adelaide. During the last 12 months a number of supply lines have been erected, linking up many centres of population which previously had not known the advantages of electricity. Amongst the supply schemes which have been brought into successful functioning is that of the Mid-North Electricity Co. Ltd., which commenced giving service on July 1, 1925. The

engine room, which consists of a wood and iron wall, will be removed and the engine room lengthened by 30 ft.

The generating plant, Fig. 2, consists of three Fairbanks-Morse crude oil engine sets. There are two 120 h.p. two cylinder engines direct coupled to 75 kv.a. alternators, and one 60 h.p. single cylinder engine direct coupled to a 40 kv.a. alternator. The exciters of all the sets are belt driven. The engines are of the vertical two-cycle type, running at 250 r.p.m., and the

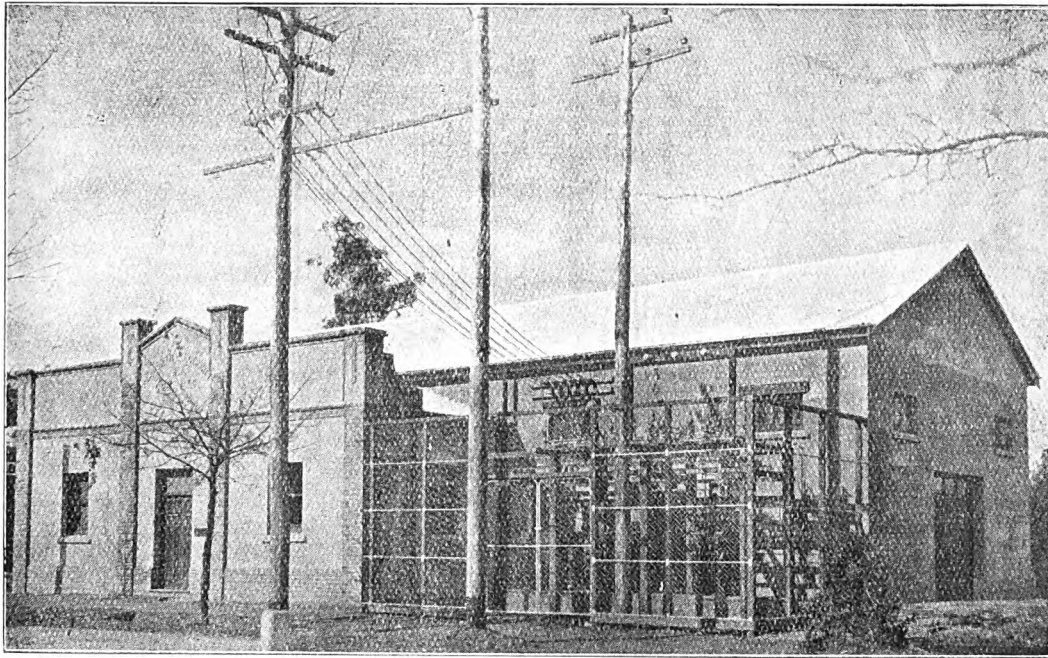


Fig. 1. Power House and Office of Mid-North Electricity Co. Ltd., Clare, S.A.

registered office of the company and the power house are situated at Clare, a town about 80 miles north of Adelaide. Electric supply is given to the towns of Clare, Watervale, Auburn, Saddleworth and Riverton, the last named being about 55 miles from Adelaide.

The power house building, Fig. 1, consists of an engine room, general offices and store. The engine room is 66 ft. long, 30 ft. wide and 15 ft. 6 in. high and is floored with concrete finished off with red oxide. At the eastern end of the room is a temporary structure for the store and a sleeping room and bath room for the operating engineer, who remains on the premises all night. When the demand for energy warrants extensions being made to the plant this temporary structure will be removed, leaving space for an additional generating set. For further extensions the east end of the

principal parts of the single and two cylinder sets are interchangeable. When the sets are running there is a complete absence of vibration, it being possible to balance a penny on edge on any engine bed while the engine is under load. These sets operate quite successfully in parallel, delivering 415/240 volt, three phase 50 cycle energy. When the plant design was under consideration doubts were expressed in certain quarters as to whether crude oil engines of this type with such difference of capacity would be suitable as prime movers for alternators to be operated in parallel. The makers of the plant, however, gave excellent guarantees, which have been sustained both under test and in normal service. Under test, groups of two sets were first run in parallel, and then the three sets were put into parallel operation together. The first tests were on steady loads at different

fractions of the rated capacity. After satisfactory operation under these conditions the sets were subjected to a fluctuating load test, in which the load was made to vary momentarily from very light load to overload, but even under these severe conditions, there appeared no inclination on the part of any set to break away from parallel operation.

The engines are of the cold starting type, and it is possible to have an engine working under load in about 30 seconds after the operator enters the engine room. They run equally well on all conditions of load from very light to full rated capacity without any adjustments or attention. Each engine has been found to stand up to its

warrants extensions to the plant a 240 h.p. set will be installed in addition to the present units. Later it is possible that 360 h.p. sets will also be installed.

Bulk storage for fuel oil is provided by tanks of 9,000 gal. total capacity situated at the rear of the power house. These are connected by a 2½ in. galvanised iron pipe with the Clare railway yard which is at an elevation of 25 ft. above the tanks. It is quite simple, therefore, to run the oil from the tank trucks at the railway siding, by means of a flexible coupling to the pipe line, into the storage tanks.

The electrical energy from the generators is controlled by a slate panel switchboard con-

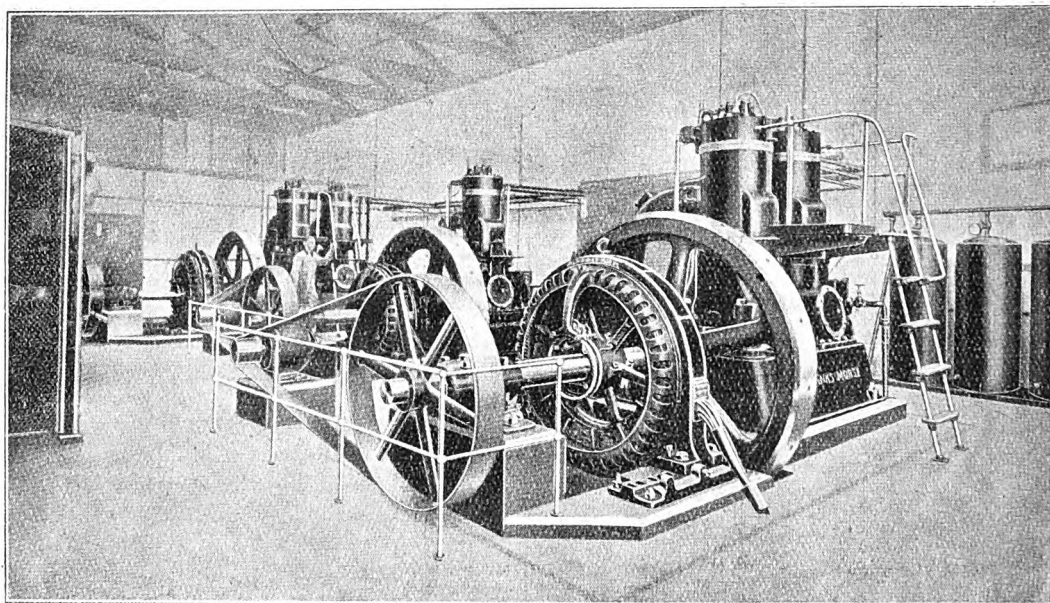


Fig. 2. Engine Room of Clare Power Station

guaranteed fuel consumption, viz., .44 lb. of crude oil per b.h.p. hour on full load, .46 lb. on three-quarter load, and .54 lb. on half load, the calorific value of the fuel being 19,000 B.th.u. per lb. As far as lubricating oil is concerned the engines were not at first cut down to their guaranteed consumption of not more than one gallon of new oil used per 2,000 rated h.p. hours, as it is advisable to over-lubricate until such time as the wearing surfaces receive a smooth polish. The quantity of oil, however, has now been cut down and each engine is working on its guaranteed consumption.

Under present conditions the 60 h.p. set runs unattended during the period of light load, from 11 p.m. till 7 a.m. The operating engineer, however, sleeps on the premises, and an alarm bell is provided, connected to the engine in such a manner as to ring should anything untoward occur. When the demand for electrical energy

constructed by Metropolitan-Vickers (Aust.) Pty. Ltd., Melbourne. From this board the town of Clare is supplied at 415/240 volts three phase. For service to the outlying parts and the distant towns the energy is stepped up to 11,000 volts by means of outdoor type transformers situated in a small yard in front of the engine room. This outdoor step-up station may be seen in Fig. 1. The h.t. transmission lines are constructed of aluminium steel cored cables, supported on 35-ft. and 40-ft. ironbark poles, with pin type insulators. At the various towns the energy is stepped down to 415/240 volts again for distribution. The transformers at the step up and step down stations were manufactured by the Metropolitan-Vickers Electrical Co., England, all the transmission and distribution cables were manufactured by Metal Manufacturers Ltd., Port Kembla, N.S.W., and the h.t. and l.t. insulators were manufactured by the Australian Porcelain Co. Pty. Ltd., Melbourne.

At the request of the leading residents of each town, the Mid-North Electricity Co. Ltd. undertook to supervise the installation of electric wiring in consumers' premises. The company provided order forms on which was printed a detailed specification with which the work had to comply, together with a schedule of the prices chargeable for the standard class of work. Installations were carried out at a minimum price of 29/- per point, and only the best English material has been used. The company sublet the whole of the wiring in Clare, Watervale, and Auburn, to Messrs. Gerard and Goodman Ltd., of Adelaide, and the Saddleworth and Riverton sections of the work to Messrs. Dankel and Co., of Adelaide. It speaks volumes for the system adopted by the company, and for the contractors mentioned, that every resident is entirely satisfied with the work. The house service meters used are the product of the Electricity Meter Manufacturing Co. Ltd., Sydney.

An agreement has recently been entered into between the Mid-North Electricity Co. Ltd., and the Neales district council for the supply of electric light and power to the town of Eudunda, about 25 miles east of Riverton, by July 1, 1926. Some of the preliminary work has been

already completed, and the company hopes to switch on the light in Eudunda not later than March, 1926. The transmission line will tap the present line at Saddleworth and pass through Marrabel, Tarnma, and Hampden, and energy will be made available to consumers in these towns.

As the country districts between the towns already being served are closely settled, it is hoped that nearly 100 farmhouses will be using electricity for lighting and domestic purposes and also for farm power. Most of the houses at Seven Hills and a group of gardener's dwellings north of Watervale have already been wired up. Farmer consumers are usually divided into groups and the high tension line tapped by small single phase transformers located as nearly as possible in the centre of each group.

The entire electric supply scheme was designed by Mr. W. H. Whitney, engineer and manager of the company, and all the construction work was carried out under his supervision. It has been the company's policy to purchase only the best of plant and materials and install these in such a manner as to give the most reliable service to the consumers. The undertaking has now been running for six months without a hitch.

The Layout of Outdoor Switchgear

By R.R.

Outdoor switching equipment is seldom built for any but the higher pressures. In the design and layout of the gear the designer has to meet many new conditions. Some he will anticipate but there are others that he must deduce from his own experience and failures, or from those of other designers.

For outdoor service a particular type of oil immersed circuit breaker with special insulator bushings is used. The breakers are equipped either for hand or for electrical remote control, and they are usually mounted on concrete foundations beneath the steelwork which carries the rest of the gear. Isolating switches and air-break switches are also used, the former operated by poles or sticks, and the latter mechanically operated from the ground level by means of some system of rods and levers. Switches of both these types are much larger than those which would be used indoors. The busbars and connections also are much stiffer, the spacing between phases is larger, and the distance between points of support is longer.

The insulators which carry the conductors may be either of the strain or of the post type. Construction with the strain type is

usually the more expensive since greater loads may be placed upon the supporting structure, and the arranging of the cross connections necessitates higher structures. The structures are sometimes of wood, but are usually built up of steel—lattice work girders and towers above 100 kv., and simpler aggregations of channels and rolled steel joists for lower pressures. Reinforced concrete also has been used very successfully for pressures up to 50 kv.

The basis of all switchgear layout is, of course, the diagram, but once this has been decided upon, the really hard work must be faced, particularly if the amount of gear is large or the arrangement elaborate. First the height above ground of the lowest live conductor must be decided upon. It is usually convenient to place the stick-operated isolating switches at this height. Next some idea concerning the limiting distances between earth and conductor and between various conductors must be obtained. Values for these distances and the clearances which appear to be justified in practice are shown in Fig. 1. It will be noticed, however, that the actual minimum values for A will be often determined by the heights or lengths of the insulators used. Curve C is the clearance

to be used between parallel phase conductors such as buses, whether they are flexible or rigid. The distances between phases of airbreak switches means between centres, but it is to be noted that these switches should be used to break transformer magnetising currents or small capacity currents only, not load currents of any appreciable magnitude. Mechanically operated isolating switches of the rotating centre-post pattern should be spaced, so that there is the phase (jumper) clearance between blades when in the open position. Ordinary isolating switches should not be placed closer than to give the phase (jumper) clearances.

which is seldom uniform over the string length; but at the moment of flashover this gradient becomes uniform. At present, all questions of potential gradient on suspension insulators may be considered as being academic only.

Where the connections in outdoor switchgear are comparatively short, it is customary to use line material, but copper tube is more rigid and is preferred for gaps up to about six or eight feet. If the connections or buses are strained (tensilely) between strain insulator strings, line material or preferably copper tube (especially if there is danger of corona) is used. Buses and connections supported or suspended from

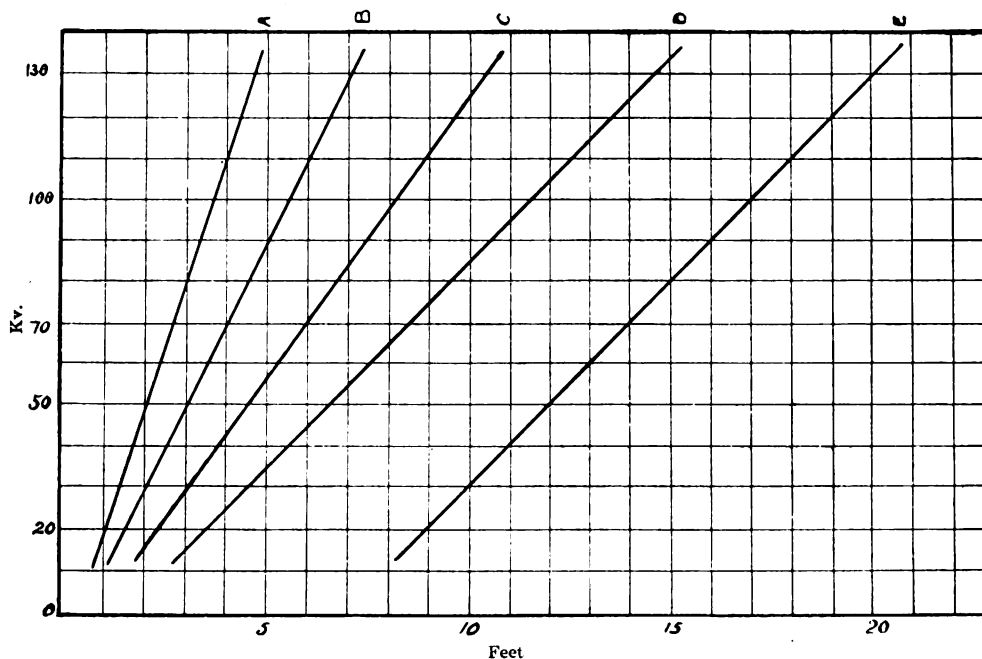


Fig. 1

A—Minimum clearance conductor to earth.
B—Minimum clearance between phases (jumpers).
C—Minimum clearance between phases (buses).

D—Minimum clearance between phases (air breaks).
E—Minimum clearance between isolating switch blade and ground.

Some difficulty has been experienced in obtaining even tentative sizes of insulators to be used on outdoor gear. There is a marked disagreement among manufacturers also upon the rating basis of insulators. The limits of insulation in practice are wet and dry flashovers, and based upon such figures and the rated voltage of the system, so-called factors of safety could be deduced. From investigation of a number of insulator catalogues, curves of such safety factors have been produced, Fig. 2. In addition to the wet and dry flashovers there is another known as the impulse flashover, which occurs at high frequencies and is the same under wet or dry conditions. This impulse flashover is no criterion of reliability of service, since it is usually several times the value of flashover at normal frequencies. Much prominence has been given of recent years to potential gradient,

post insulators usually give the cheaper and more compact construction, but the spans from support to support may be excessive for the higher pressures. Copper tube has been used very successfully but is expensive. A cheaper and in some ways a better construction makes use of galvanised iron pipes. Rolled steel sections also have been used advantageously.

No limits of construction for buses and connections have yet been standardised but, since the greater portion of the load upon such a busbar is due to its own weight, some reasonable limits might easily be formulated. The limit of stress might be placed at 20,000 lb. per sq. in. for mild steel. The other limit, which is imposed by sightliness only, is the deflection in the middle of the span, and a suggestion for this is one inch per 15 ft. of span, i.e., 1/180 of the span.

Let I = moment of inertia of the busbar section,
 Z = modulus of section of the busbar section,
 W = weight per inch length,
 and L = span in inches.

Then:—

$$\text{Total weight of busbar} = WL$$

$$\text{Max. bending moment} = \frac{WL^2}{8}$$

$$\text{Max. deflection} = \frac{5}{384} \frac{WL^4}{EI}$$

$$\text{Max. stress} = \frac{WL^2}{8Z}$$

Inserting the limit for stress, we obtain:

$$L = 400 \sqrt{\frac{Z}{W}}$$

$$\text{or } \frac{W}{Z} = \frac{160,000}{L^2}$$

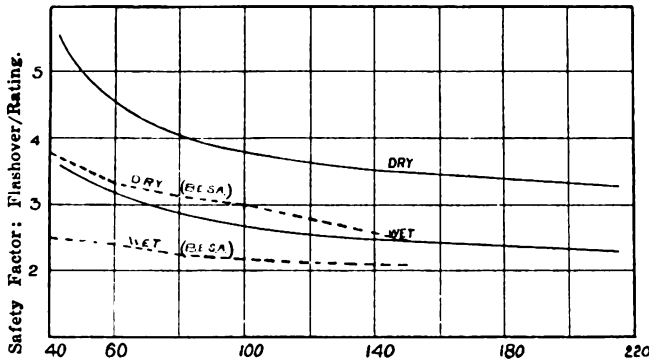


Fig. 2

Similarly apply the limit for deflection and putting $E = 30 \times 10^6$ we obtain:

$$L = 235 \sqrt[3]{\frac{I}{W}}$$

$$\text{or } \frac{I}{W} = \frac{L^3}{12.8 \times 10^6}$$

By applying formulæ for weight, moment of inertia, and modulus of section we may obtain approximate limits for galvanised iron pipes.

Led D = outside diameter of pipe,
 and t = thickness of wall.

Then:—

$$\text{For thin walled pipes: } I = \frac{\pi}{8} t D^4$$

$$Z = \frac{\pi t D^3}{4}$$

$$W = .283 \pi t D$$

With the limiting stress we obtain:

$$L = 375 \sqrt{D}$$

But with the deflection as the limiting factor:

$$L = 180 \sqrt[3]{D^2}$$

Table I.

Pipe nom. dia.	Actual dia.	L (stress limit)	L (deflection limit)
in.	in.	ft.	ft.
1	1.3	35.7	18
1½	1.89	43	23
2	2.32	48	26
2½	3.0	54	31
3	3.5	58.5	34.5
3½	4.0	62.5	38
4	4.5	66	41

The deflection limits taken are fairly generous, but from Table I it will be observed that the deflection is, as a rule, the limiting factor. Galvanised iron pipes can therefore be used in many constructions, but when they are doubtful, some form of rolled steel section such as a tee, might suit. Where, however, the span is very great, some form of built up girder which is symmetrical in section should be used. A triangular section with three equally spaced booms makes an excellent design.

There are also some points which must be observed where rigid steel or iron connections are used. All connections must be bolted and, to allow for strains in the connections and strains in the supporting structures, some form of flexible connection by which the rigid conductor may be hung from the end of the post insulator, must be used.

CO-OPERATIVE ELECTRICAL PUBLICITY

A suggestion has been made in New Zealand that concerted action be taken in the direction of educating the general public as to the possible uses of electricity. It is suggested that there should be established a body operating very much as does the Electrical Development Association in Great Britain. This body would draw its funds from the government hydroelectric branch, power supply authorities, and the electrical trading interests in, roughly, equal proportions. It should devote its attentions to wide advertising through the press, with a view to popularising the more unusual uses for electricity, and, in addition, should organise electrical exhibits at appropriate places and times.

Recent events have shown that in more purely technical directions co-operation between the government departments, power supply authorities, and the electrical traders can be attained successfully and with advantage to all concerned, and it, therefore, seems reasonable to have high hopes for similar co-operation on the more purely commercial side.

Burning Pulverised Coal

Description of the Lopulco Patent System as supplied to the Birmingham, England, Electricity Department by International Combustion Ltd., London

After careful investigation, which included the inspection of some of the largest and most important pulverised coal installations in the world, the Birmingham corporation electricity department, on the advice of its general manager and chief engineer, R. A. Chaddock, M.I.E.E., decided last year in favor of the adoption of pulverised coal equipment for the extensions of the Princes station, Nechells. International Combustion Ltd. was entrusted with the important contract of applying pulverised fuel equipment to six Vickers-Spearing water-tube boilers, each having 5,400 sq. ft. heating surface, and an evaporative capacity of 35,000 lb. per hour at normal load, and 50,000 lb. per hour at maximum rating. The boilers are designed for a working pressure of 320 lb. per sq. in., and the steam is superheated to a final temperature of 700 deg. F. The type of furnace and pulverising equipment employed is that manufactured under the Lopulco patent system, the merits of which have been amply demonstrated in numerous plants in the U.S.A., and elsewhere throughout the world.

At the Princes power station the raw coal arrives by barges on the canal alongside the station, and is conveyed to the raw coal bunkers by means of telfers. The bunkers are each capable of holding 34 tons, which is sufficient for approximately six hours burning at maximum load, so that it is necessary to fill them only four times daily. The coal as received contains an average of 20 - 12 per cent total moisture, and its calorific value (dry) is 10,000 to 10,700 B.th.u. per lb.

From the raw coal bunkers the fuel passes through chutes fitted with controlling gates to the coal driers, of which there are four. These driers consist of a number of steam-heated trays arranged in tiers, which revolve within a steel casing through which hot air is passed. The air is heated to a suitable temperature by means of a steam heater, consisting of a number of coils of piping connected to inlet and outlet headers. The driers are operated by means of a small d.c. motor, with a speed range of 500/2,000 r.p.m., through special reduction gear, giving a speed of $1\frac{1}{2}$ to 6 r.p.m. on the drier shaft. Efficient mechanism for spreading and scraping the coal over the drying plates is employed, so that the coal arriving at the outlet valve on the drier contains approximately 6 - 8 per cent moisture only. The moist air issuing from the top of the drier is drawn through a fan and passed through a separating cyclone, fitted with

a vent pipe. Any dust brought over from the drier is deposited within the cyclone, whence it is returned to the system. The coal is then passed over a revolving magnetic separator, contained in a small hopper provided with two compartments, through one of which the coal passes on its way to the pulverising mills, whilst the other acts as a receptacle for any tramp iron which may have become mixed with the coal. The tramp iron is deposited automatically. A suitable door is fitted to this compartment to permit of the removal of its contents.

Before entering the pulverising mills the flow of coal is again controlled by means of an adjustable star feeder, thus ensuring the desired quantity being fed to the mills. Pulverisation is effected by means of four Raymond 6-roller low side mills, each capable of pulverising six tons of coal per hour. The guaranteed fineness is 85 per cent through a 200-mesh sieve and 95 per cent through a 100-mesh sieve, none being left on a 40-mesh sieve. Each mill is operated by a 75 h.p. constant speed a.c. enclosed ventilated type motor, connected to the mill by means of a flexible coupling.

The fineness of pulverisation necessary for successful combustion depends on the amount of volatile matter contained in the fuel; for example, good bituminous coal which has a high percentage of volatile matter does not require to be ground as fine as fuel which has a low percentage of volatile matter. The ideal to be aimed at is to grind the fuel to just that degree of fineness necessary for its proper burning, and thus to use the least amount of power for driving the pulveriser and its fan, at the same time giving a uniform product. An average condition of fineness for bituminous coal is that 90 per cent passes through 100-mesh, and none of the powder is left on a 40-mesh sieve; whereas some anthracite coals must all pass a 60-mesh sieve, and 80 per cent go through 200-mesh.

The Raymond roller pulveriser (Fig. 1) with air separation has been adopted for the Lopulco system because it grinds a very uniform product with a minimum amount of power. It has a heavy cast iron base plate with tangential air openings. Fixed to the base plate is a large horizontal bull ring of special steel, also a footstep bearing for the shaft. A number of special steel ploughs are attached to the bottom of the main shaft; at the top there is a spider, the arms of which carry pivotally-suspended bearings for the vertical roller shafts, which act

as heavy pendulums. The rollers run round inside the bull ring. Their number varies from two to six, according to the output of the mill, each roller representing an output of about one ton of fuel per hour for ordinary bituminous coal. The output from a given size of pulveriser depends on the physical condition of the fuel, the proportion of smalls, moisture content, and the fineness of pulverisation which it is desired to maintain. The rollers are made of cast iron with deeply chilled surfaces, and when the main shaft rotates they are thrown by centrifugal force against the bull ring.

The top of the pulveriser supports a pipe of large diameter which connects to the exhauster fan; this, in turn, connects to the cyclone which is situated near the top of the pulverising plant. The function of the cyclone is simply to separate

The fuel is fed to the roller pulveriser from the drier in pieces of such size that they will all pass through a 1½-in. diameter ring. The rate of feed is regulated by automatic mechanism capable of giving infinite variation. The pieces drop to the bottom of the grinding chamber, where they are picked up by the rotating ploughs and thrown between the rollers and pulverising or bull ring. Each plough is located just ahead of its roller, and a constant stream of material is thrown between the pulverising surfaces, thus preventing metal-to-metal contact and allowing the pulveriser to run quietly with very little wear.

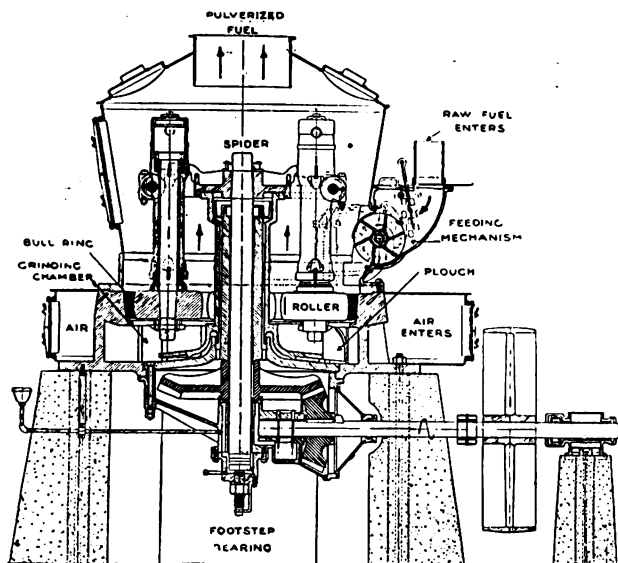


Fig. 1. Raymond Roller Pulveriser

the pulverised fuel from the air; the air then returns to the pulveriser. A pipe from the cyclone brings back the air to the tangential openings in the base plate, thus providing for continuous circulation of the same air, which is kept under slight sub-pressure in the pulveriser chamber. The exhauster fan runs at constant speed, and the pull on the particles in the grinding chamber varies according to the amount of raw fuel fed in as compared with the amount of pulverised fuel taken out. In order to regulate correctly the amount of fuel going into and out of the pulveriser to suit the various loads, a pneumatic control device is used which actuates the pawls of the feed mechanism in accordance with the varying vacuum in the grinding chamber. The upper casing of the grinding chamber is entirely enclosed, and has inspection doors to enable all the working parts to be easily attended to when necessary.

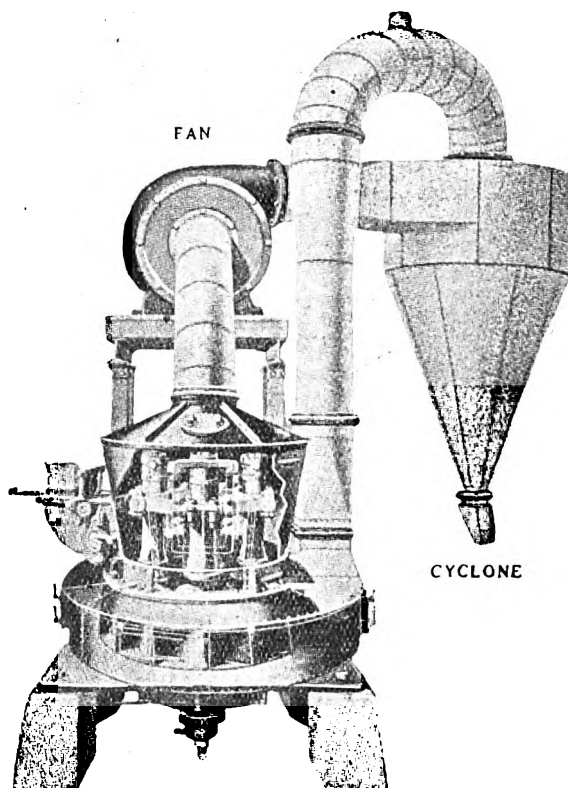


Fig. 2. Raymond Pulveriser and Cyclone

The pulveriser is fitted with an easy method of adjustment by which the fuel can be ground to any desired fineness, and this fineness can be maintained with certainty so long as the particular quality of fuel is passing through the mill. No advantage is gained by having higher percentages to go through the finer mesh sieve than required for efficient burning, but considerable loss may be caused if there are any particles too large to go through the coarser sieve.

The pulverised coal is extracted from the mills by means of exhausters, as described above. Each exhauster is driven through a flexible coupling by means of a 45 h.p. constant speed a.c. motor. A separate exhauster serves each

mill. Air-tight piping conveys the powdered fuel to the cyclone (Fig. 2) fixed above the pulverised coal bins. From the cyclone the coal passes on to the special equipment used for conveying the fuel to the pulverised coal storage bins. Should there be a breakdown on the milling plant, the boilers draw from these reservoirs and can remain on full load for a considerable period.

In this installation, Fuller-Kinyon pumps have been utilised for this fuel conveying. These pumps consist essentially of a screw propeller, of special design and varying pitch, driven by means of a constant speed, a.c., enclosed ventilated type motor, with slip rings and short circuiting device to facilitate starting. The stuffing boxes of these pumps are of special design to prevent clogging with coal dust and the attendant risk of trouble through heat generated by excessive friction.

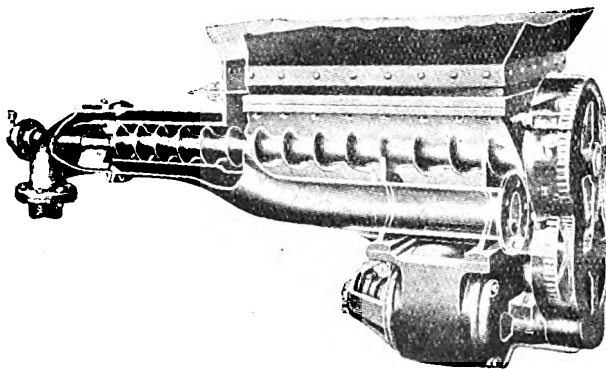


Fig. 3. Lopulco Single Feeder

Incorporated with the fuel transport system is a small compressed air equipment, complete with receiver and after-cooler, which operates in conjunction with the fuller-Kinyon pumps and assists in conveying the fuel to the pulverised fuel storage bins. The compressors are designed for operating at 50-100 lb. pressure, the lower figure being the normal delivering pressure for the conveyance of the fuel, while the higher can be used in the event of a coal delivery pipe becoming clogged, in which case it is usual to blow the air back to the pumps. The pulverised coal delivery mains at Birmingham are 5 in. diameter and have a total lineal length of approximately 270 ft. including a vertical lift of 60' ft. It is anticipated that not more than 40 lb. pressure on the compressors will be required for these conditions.

At each pulverised coal bin is fitted a special electro-pneumatic control valve, operated by means of a small push button at the point where the pumps are installed. By means of these and a further automatic device the bins can be filled successively or any particular bin missed, as may be desired.

Another feature of the equipment is the level indicators used in the pulverised coal bins. These consist of a paddle connected electrically to the switchboard situated at the pump operating level, so that when the bin is full a lamp is lighted or extinguished according to the method adopted for connecting the electrical circuit. The introduction of a second paddle allows the operator to know when the bin is empty, and suitable colored lights on the switchboard serve to acquaint the operator accordingly.

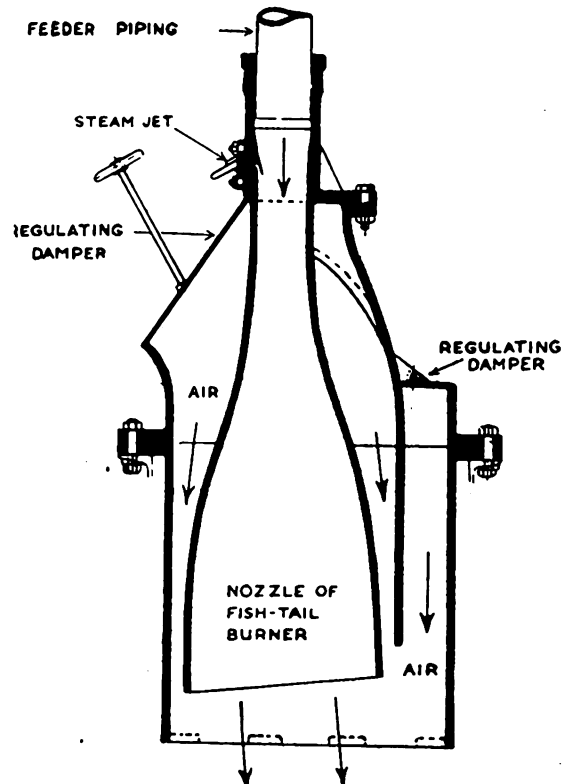


Fig. 4. Section of Lopulco Burner

From the storage bins the coal passes on through air-tight piping to the feeders, which consist essentially of cast iron screws contained in a substantial casing. The shank of each screw is of a varying diameter, so that the fuel clears itself as it is driven rapidly through a pipe to its burner. The casing containing the screws forms the bottom of a hopper attached to the storage bin, and when the gate valve is open the fuel falls on the screws by gravity, the opening being large enough to ensure that the fuel will not arch and so stop the supply. The screws have a speed range of about four to one, in order that the fuel may be fed forward at any desired rate to suit the load on the boiler. If desired, the control can be made from a distant switchboard. When direct current is available the electric motors are of the vari-

able speed type, but when the supply is alternating current a mechanical apparatus is used to vary the speed.

A paddle is keyed on to the delivery end of each steel shaft, and by its quick revolution the fuel is thoroughly mixed with the primary or carrying air which is introduced at this point, giving equal aeration to all the particles. The primary air is under pressure and carries the mixture (which is now practically a mechanical gas) through a relatively short steel pipe to the burner situated immediately below it. To avoid packing of the fuel by condensation of moisture, the primary air is slightly preheated by being passed through passages either in the side walls of the combustion chamber or the sloping walls of the ash hopper chamber.

For large boilers there may be ten or more feeders in one group, with two motors to drive them, and, as each feeder and its burner are independent, it is possible for one pair to be cut off without interfering with any of the others. Fig. 3 shows a single feeder. In the Birmingham contract six four-group feeders, arranged in pairs of two on each side of the driving motors, are employed.

The coal is thus conveyed to the burners (Fig. 4), of which four are fitted to each of the combustion chambers. Each burner has a fan-shaped nozzle, which gives a flat stream of fuel and primary air, thus providing for much greater exposure of the coal particles than would be possible with a round nozzle to carry the same amount of coal. Around the fan-shaped nozzle there are passages through which cold air is induced, the exact amount being regulated by two dampers, which can be exactly adjusted by screws. This cold air cools the nozzle and at the same time supplies enough oxygen for ignition of any variety of fuel at the burner nozzle. The burners are supported above the arch of the combustion chamber in such a way that the flat sides of the nozzle are practically parallel to the front wall.

The Lopulco system is based on the principle that combustion is a progressive process, and the streams of coal which are projected vertically down into the combustion chamber encounter cross currents of secondary air introduced through ports in the front wall. This secondary air, preheated by virtue of having traversed the hollow combustion chamber walls, is introduced at right angles to the vertical stream of coal. It passes well into the centre of the combustion chamber and there mingles intimately with the incandescent particles. As the flame reaches the lower zone it loses its downward velocity, doubles back on itself, passes upward at the rear of the combustion chamber, and thence to the boiler tubes which are immediately above. This arrangement permits a longer flame travel

than any other method of firing, and gives ample time for complete combustion, whilst ensuring that a minimum amount of ash passes over to the flues.

A typical combustion chamber of the Lopulco system is shown in Fig. 5, from which it will be seen that the boiler is placed directly over the chamber, and the burners are carried on a suspended arch. The combustion chamber is constructed in such a manner that it is free to expand and contract without detriment to the

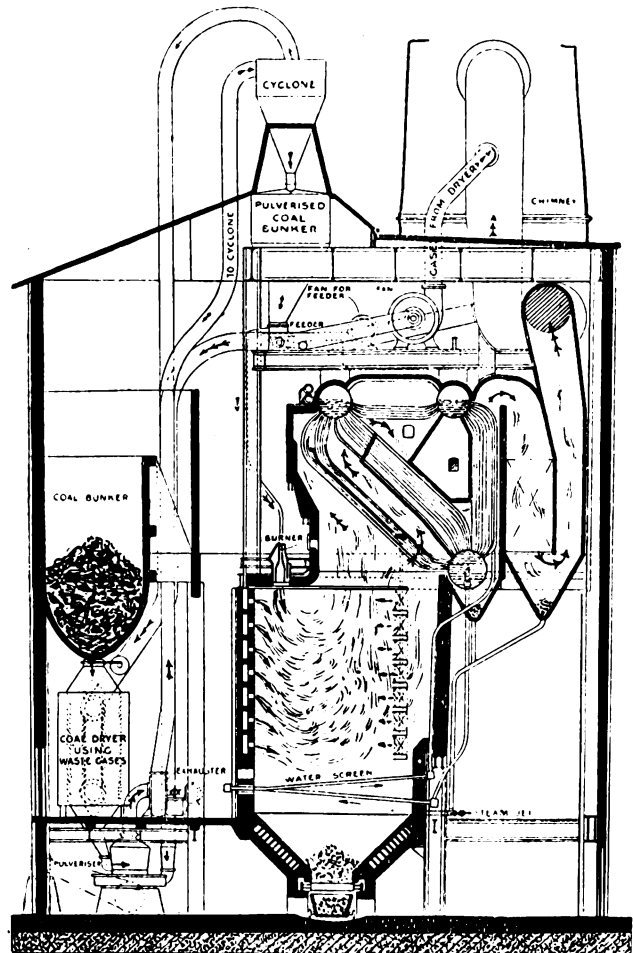


Fig. 5. Arrangement of Lopulco Pulverised Fuel Plant and Ladd-Belleville Boiler, supplied to the Vitry Power House near Paris by International Combustion Ltd., London

brickwork. It is built with hollow walls, through which streams of secondary air are drawn and preheated. At the same time, this air cools the brickwork. By this means, heat is removed that would otherwise be stored in the brickwork, and thus the life of the brickwork is prolonged and radiation losses minimised. The amount of air circulated is controlled by doors located in the side walls. All the doors are actuated by a single hand-wheel, their adjustment being such that the correct amount of air for complete combustion enters each zone of the flame area.

The water screen is an important and exclusive feature of the Lopulco system. Its principal use is to prevent slagging of the ash at the bottom of the combustion chamber. The screen consists of seamless steel tubes, set nearly horizontally across the bottom of the combustion chamber, the tubes being expanded into forged steel headers at the front and rear of the chamber, these in turn being connected to the boiler by the down-take and riser piping. The tubes are spaced some distance apart, and, as the ash drops from the flame, it passes between them, and is chilled below fusing point, falling into the ash hopper in the form of fine, dry particles which are easy to remove. The temperatures at points a short distance above and below the water screen indicate very rapid heat absorption by the water in the tubes, which form a material extension of the boiler heating surface. The high rate of absorption is due to the tubes of the water screen being fully

exposed to radiation from the cloud of incandescent particles in the flames. One advantage of the water screen is that it lowers the average temperature of the combustion chamber in such manner as to protect the brickwork, and thus the temperature in the interior of the flame can be kept very high. The amount of excess air is a minimum, and this gives uniformly high CO_2 in the flue gases over extended periods and at all loads.

A report issued by the American Institution of Electrical Engineers shows that during 1923 more than 8,000,000 tons of coal were burnt in pulverised form in various power stations. These figures, in themselves, show the tremendous advance made in recent times in the burning of coal in a pulverised form. International Combustion Ltd., of London, the proprietor of the Lopulco pulverised fuel system, has opened an Australian office at Kembla buildings, Sydney, under the control of Mr. E. Harland Hutchinson.

Prize-Winning Mine Locomotive

Some little time ago in England a prize of £1,000 was offered by Mr. Charles Markham to stimulate the development of electric locomotives for use in mines. The conditions of service were, of course, very rigid and the competition was really limited to machines of the storage battery type. Five models entered the final competition, and the prize was awarded to Messrs. Joseph Booth and Bros. Ltd., of Leeds. The Booth locomotive consists of two units: (a) a mechanical unit, consisting of the two axles and brake gear, mounted on an inner frame, and (b) an electrical unit, comprising an outer frame carrying the motor, controller, resistance, circuit breaker, and all the electric cables. The battery cells are mounted in groups in hardwood crates housed in two flame-proof steel boxes supported on rollers mounted on the locomotive frame. The whole battery may be rolled off the machine when discharged, and replaced by a fresh battery in about five minutes. The construction with separate mechanical and electrical units relieves the electrical equipment, including the battery, and also the driver, of shock due to the track, whilst for the purpose of overhaul the two units can be separated by unskilled labor. When the battery is rolled clear the whole mechanism is visible for inspection. The dimensions of the machine are: length 10 ft., width 3 ft. 6 in., height 3 ft. 6 in. The locomotive is capable of hauling a load of 5 tons on the level at approximately 6 m.p.h.

or 20 tons at 3 m.p.h. The starting pull is approximately 2,000 lb.

The battery is of the Kathanode type, made by the D.P. Battery Co. Ltd. The motor was manufactured by Messrs. Booth and is of the four pole type. It is placed at the end remote from the driver, and transmits power through a cardan shaft to a free coasting worm and wheel on the axle nearest to the driver. The two axles are coupled together by connecting links placed at right angles. Brake gear operating on the rims of all four wheels is provided, the brake shoes being lined with Ferodo. For the motor control there is a d.p. circuit breaker and a drum controller. The control resistance is of the "unbreakable" grid type, constructed of easily detachable units mounted in a flame-proof welded mild steel case.

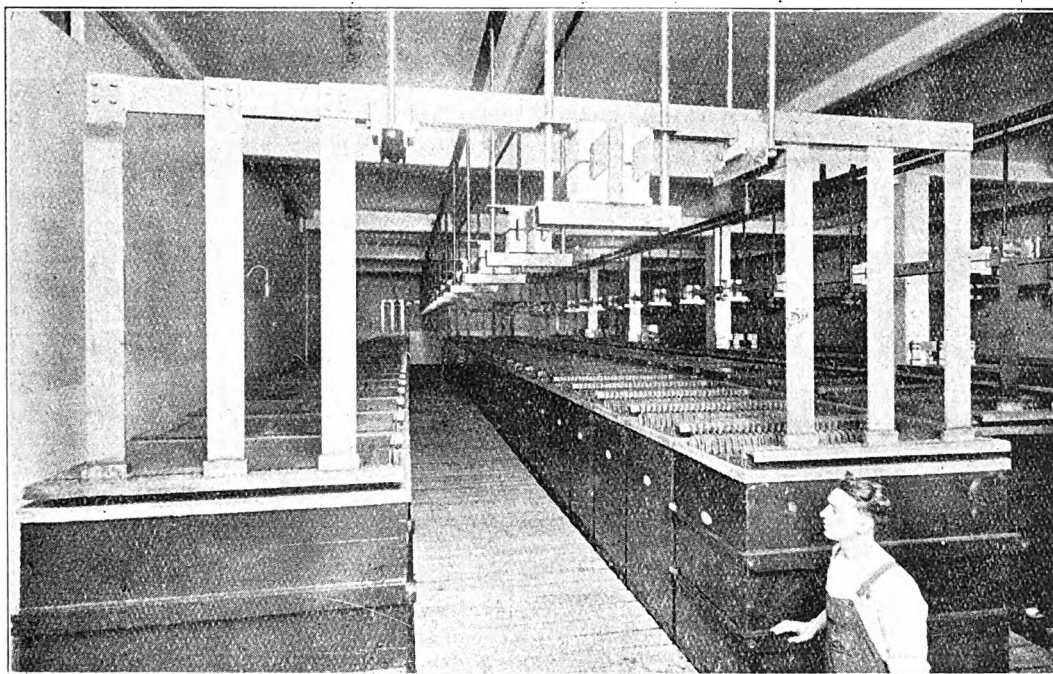
The whole construction is thoroughly flame-proof throughout. All the electrical units are equipped with flame-proof terminal boxes, fixed insulated studs being provided for carrying the conductors from the terminal boxes into the main housings. All the cables are totally enclosed in steel tubing screwed into the terminal boxes on each unit. The whole machine is fire-proof, as any material which is liable to catch fire, or be affected by excessive heat, is encased; should any part take fire, it is impossible for the flame to reach the external air.—"Electrical Review."

Large Storage Battery Installation

An important storage battery installation has recently been completed by the Tudor Accumulator Co. Ltd. for the Sydney municipal council at the Castlereagh street substation. The battery consists of 300 cells having a capacity of 6,696 amp. hours at the one-hour rate of discharge and a maximum charging rate of 3,200 amps. Each cell contains 31 positive plates and 32 negative plates, and the total weight per cell including electrolyte, is 5,904 lb. The cell containers are lead-lined wooden tanks 4 ft. 5 $\frac{3}{16}$ in. long by

supporting brackets are dropped at the requisite intervals.

The battery operates to give three-wire supply through two-end cell regulating switches. These switches embrace a copper saving device. Each switch has eight contacts, four regulating cells being connected between adjacent contacts. Two sliding brushes are used on each switch. Both brushes are fixed to one arm, and thus move together, providing two steps for each contact. When increasing voltage, the first step of the



Portion of New Tudor Battery for Sydney City Council

2 ft. 3 $\frac{3}{16}$ in. wide by 3 ft. 9 $\frac{3}{4}$ in. deep. The positive plates are of the large surface Plante type, and the negative plates are of the box type. The dimensions of the plates are 20 $\frac{3}{8}$ in. by 28 $\frac{13}{16}$ in. by 10.4 mm. thickness. The separation between the plates consists of chemically treated woodboards, from which all organic acids and other deleterious substances have been extracted.

The battery is arranged on two floors. The illustration gives an idea of the general arrangement on one of these floors. The inter-row connections and the connections from the battery terminals to the regulating switch and switchboard are made up of three bars of 5 in. by 0.54 in. hard drawn copper. The copper conductors are hung from the ceiling girders by means of channel iron runners, from which

switch carries the first sliding brush off the cell contact, and the second sliding brush on to the same contact, the latter bringing two jockey cells into circuit. The second step carries the first sliding brush on to the next contact, thus switching into circuit the four cells between the contacts, and at the same time, carries the second sliding brush off the first contact. This cuts out the jockey cells. When reducing voltage, the sequence of operation is reversed. This design of switch reduces the number of regulating leads for each battery from 14 to eight, but the total range of regulation is the same, and the actual increase or decrease per step is equivalent to the voltage of two cells. The regulating switches are motor-driven, and are remote controlled from the d.c. switchboard, which is on the ground floor of the substation.

On completion of erection in August last, the city council carried out tests for the purpose of ascertaining whether the capacities and efficiencies guaranteed by the contractor had been obtained. The battery was discharged first to its full capacity at the three-hour rate, i.e., 3,200 amps for three hours. It was then charged and again discharged to its full capacity at the one-hour rate (6,696 amps). The results of the tests, which were eminently satisfactory, are set out in the accompanying table.

	3-hour rate		1-hour rate	
	Guaranteed	Attained on Test	Guaranteed	Attained on Test
Efficiencies (per cent)—				
Watt hour	70	73.4	66	69.2
Ampere hour	90	90	90	90
Final voltage per cell	1.75	1.82	1.70	1.74
Temperature rise—				
	Guaranteed		Attained on test	
	Not exceeding 13 deg. F.		9 deg. F.	

Other large battery contracts at present being handled by the Tudor Accumulator Co. Ltd. in Australia include the main battery and counter e.m.f. cells for the new automatic telephone exchange, City East, Castlereagh street, Sydney, four batteries for the new power station and substations of the City Electric Light Co., Brisbane, and the renewal of the large buffer battery at the Malvern substation of the Melbourne tramways board.

MELBOURNE ELECTRIC RAILWAYS

Mr. H. Clapp, chairman of commissioners of the Victorian railways, stated recently that since the inauguration of electric traction on the Melbourne suburban lines in 1919, the number of passengers carried annually on the suburban system has increased from 104 millions to 159 millions. It is estimated that, as a result of the superior train services provided by electric traction, the traffic increase has been such that the additional revenue has been sufficient to pay the interest on the cost of the whole scheme of electrification. Nevertheless the electrified system is not wholly paying its way for there is no provision made for depreciation.

The system has recently been extended by the electrification of outer suburban services to Ferntree Gully and Lilydale, both about 23 miles from Melbourne. An idea of the improvement of service under electric traction may be obtained from the fact that under steam operation the journey to Lilydale took 82 minutes, while under electric operation it takes 58 minutes. A further extension of electrification from Eltham to Hurstbridge is under consideration.

LARGE CRUDE OIL POWER UNITS

In the January number of the Commonwealth Engineer, Mr. G. B. Vickers describes the large crude oil engines taken from the recently dismantled ex-British submarines. Each submarine was equipped with three 1,200 b.h.p. solid injection oil engines of the vertical fully-enclosed type, built by Vickers Ltd., of Barrow-in-Furness. Each engine consists of 12 cylinders working on the four-stroke cycle at 300-390 r.p.m. The indicated h.p. of the engine is 1,350. thus the mechanical efficiency is 89 per cent. In addition the engine has capacity to carry a 20 per cent overload. The crankshaft is built up in four sections each having three cranks. This enables the engine to be split up into three cylinder or six cylinder units, giving 300 h.p. or 600 h.p. respectively. A four-stage air compressor is used for charging the air bottles required for starting purposes only. Each cylinder is provided with an automatic starting valve, thus the engine has no dead centre and can be started in any position. The air starting pressure required is about 800 lb., and when the air compressor has charged the storage bottles up to 1,200 lb. there is sufficient storage to start the engine twice each day for a week without recharging.

The Melbourne Salvage Pty. Ltd., of 60 Queen street, Melbourne, which carried out the dismantling of the submarines, has several of these engines with spare parts for sale, either as complete engines or in units of 300 or 600 h.p. Some of the engines have already been installed around Melbourne and are giving good service, notably one of 1,200 h.p. which drives an electric generator at the harvester works of Messrs. H. V. McKay Pty. Ltd., Sunshine. This set generates at a cost of one-fifth of a penny per unit on a fuel consumption of under 0.45 lb. of crude oil per b.h.p. per hour. The space occupied by the engine is quite small for the power developed, the overall dimensions being: length 30 ft. 6 in., width 4 ft., height 8 ft. The weight is less than 30 tons. Another engine, of 600 h.p., is giving good service driving quarrying plant near Melbourne. Melbourne Salvage Pty. Ltd., 60 Queen street, Melbourne, is in a position to give purchasers expert advice on the operation of these engines.

The Victorian railways standing committee has approved of the extension of electrified service from Eltham to Hurstbridge. The work will involve the conversion of $6\frac{3}{4}$ miles of main track and nearly a mile of sidings, and the erection of a 1,000-kw. automatic substation at Diamond Creek. The total cost is estimated at £51,303.

Melbourne Tramway Conversion

Rapid progress is being made with the conversion of the Melbourne-St. Kilda tramway routes from cable to electric traction. The contractor for the work of removing the cable tracks and laying the permanent way for the electric cars is the Foundation Co. Ltd., of London. The contract involves the conversion of 35,730 ft. of double track. This includes 13,500 ft. in St. Kilda road, 6,000 ft. in High street, 2,590 ft. in Wellington street, 2,330 ft. in Fitzroy street and 2,110 ft. in the Esplanade, St. Kilda, and about 2,500 ft. in Swanston street, Melbourne. In addition new track with a length of 4,500 ft. is to be laid in Brighton road beyond the present terminus of the line in High

run to Flinders street. The conversion on the bridge was carried out by the tramways board by day labor under the direct supervision of the board's technical staff, and the electric cars were running eight days after the cable cars had been stopped. The length of double track converted is over 800 ft. In reality two bridges are crossed in this section, one across the river and the other across the railway tracks at the entrance to Flinders street station. As the bridges differ greatly in design different methods were required for constructing the foundations of the permanent way. Advantage was taken of the fact that the track centres of the electric per-

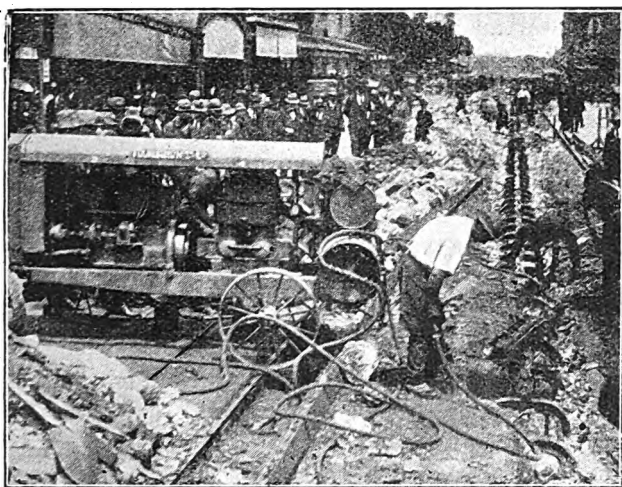


Fig. 1. Swanston Street Tramway Conversion: Removal of Cable Tracks.



Fig. 2. Electric Track in Position Ready for Concreting

street, St. Kilda. The sections in Wellington street, Fitzroy street and the Esplanade, St. Kilda, have already been completed. The work of converting the main route in St. Kilda road is about to be commenced, and while it is in progress the convenience of the public will be met by an electric service running on temporary ballasted tracks laid at the roadside along portion of the road and linking up with the newly opened line in Sturt street, South Melbourne. By this means passengers will be brought from the St. Kilda junction to the entrance to the city at Flinders street, after the cable cars have been shut down. Motor buses are being used to provide temporary services from the city to the Brighton road terminus of the cable line.

The conversion of the tracks across Princes bridge at the entrance to the city has just been completed, and a curve has been laid to allow the electric cars from the Sturt street line to

manent way are considerably wider than those of the cable way. By adopting concrete and stringer construction it was possible to lay the two outer electric rails while the cable cars were still running. This brought about a considerable saving in time after the cable running was shut down. The method adopted in the conversion consisted of taking up the old rails and cable slot, roofing the cable conduit with steel plates, chipping trenches in the concrete road foundation just large enough to take the rails, stringers and cross ties, and filling in with quick-setting Ciment Fondu Lafarge. The road surface was formed of wood blocks. On the railway bridge it was necessary to set the stringers for the two inner rails on channel irons as there was so little thickness of concrete above the bridge plates that sufficient bearing could not be obtained. The use of the Ciment Fondu both for rail setting and for

rendering preparatory to wood blocking effected a considerable saving in time. The board was somewhat at a disadvantage in its work on the bridges for it was unable to use mechanical means for breaking up the old concrete, both owing to the shallowness of the track foundations and because of the narrowness of the trenches required for the stringers. It was compelled, therefore, to use manual labor with spike and hammer for paving breaking.

The work of converting the tracks in Swanston street, through the centre of the city was in the hands of the contractor. It was commenced in the Christmas week in order to take advantage of the lighter vehicular traffic in the holiday period in minimising congestion. The gangs worked three shifts and on Sundays and holidays, and although the time allowed for the contract was one month, the work, involving the conversion of 2,500 ft. of double track was completed in considerably less time.

The method of working was as follows:—

The wood blocking was removed from the old permanent way, and the concrete foundation of the track broken up by means of pneumatic paving breakers. These machines were supplied by Ingersoll-Rand (Australia) Pty. Ltd. They consist of pneumatic hammer drills operated by air at 80 lb. per sq. in., the air being supplied by Ingersoll-Rand portable compressors. Fig. 1 shows one of the compressors and a battery of paving breakers at work. The removal of the concrete left exposed the upper portions of the bent steel rails forming the framing of the old cable conduit, as shown in Fig. 1. These ribs were cut off by oxy-acetylene blow-pipes at the level of the ground left exposed by the removal of the concrete. The lower portion of the concrete cable conduit was retained to act as a longitudinal drain for the new permanent way. The drain was completed by inverting unglazed earthenware half-drain tiles over the curved bottom of the conduit and filling in on top with blue metal screenings and broken concrete. The whole floor of the trench formed by the removal of the old permanent way was then covered with clinker ash well rolled down. On this the sleepers and rails for the new permanent way were laid and spiked up. The track thus formed was then raised and supported at the proper height by means of wooden blocks. This stage is shown in Fig. 2. The rails were then lined up and concrete poured beneath and around the sleepers. When this had set the road surface was paved with wood blocks, giving the finished track. Cement Fondu was only used in this construction for rendering the surface preparatory to wood blocking. There was no advantage in using it for the whole construction as there would be no traffic over the surface for some days after pouring.

The Swanston street conversion involved the relaying of four crossings over cable tram tracks: at Flinders street, Collins street, Bourke street, and Lonsdale street respectively. That at the last named crossing was somewhat complicated, as under the cable system two tracks curved into Swanston street. The new system through-routes both cable and electric lines at right angles, thus a considerable amount of cable track laying as well as electric track construction was involved. The work at all these crossings was carried out by the tramways board and in order not to interrupt traffic it had to be done in the early morning hours when the trams were shut down. Cement Fondu was largely used in these works so that the road surface and permanent way could be restored quickly for traffic.

A great deal of credit is due to the engineering staff of the tramways board for the excellent organisation which has enabled the board and the contractor to get through with the work in such quick time. Very careful prearrangement enabled the gangs to carry on expeditiously without waste of time or overlapping of effort. Coupled with this was a system of rigid supervision which kept everything moving smoothly and correctly.

HYDROELECTRIC POWER FOR NELSON, N.Z.

The growing demand for electrical energy in the city and environs of Nelson, N.Z., necessitates the provision of further generating capacity in the near future. At present the supply is given from a steam generating plant operated by the city council. The establishment of an undertaking of sufficient capacity to meet all requirements and make proper provision for future development would be a very costly business, and therefore steps are being taken, on the advice of the chief electrical engineer of the public works department, to form a power board to deal with the matter. The board will consist of representatives of the Nelson city council, the boroughs of Waimea, Richmond and Motueka, and the town of Tahunanui. Suggestions for the supply of power to the district are under consideration. Owing to the somewhat isolated position it is not economically feasible for bulk supply to be taken from any of the government hydroelectric schemes, therefore the board will have to inaugurate a generating undertaking of its own. One proposal is the development of hydroelectric power from Lake Roturoa, some sixty miles from the city. The maximum power available from this source is 45,000 kw. A 5,000-kw. development is estimated to cost about £270,000. If the necessary steps are taken to go ahead with the scheme, power will be available in 1928.

TASMANIAN HYDROELECTRIC DEPARTMENT

The hydroelectric department of Tasmania is making steady progress with the supply of electricity to many parts of the state. During the year ended June 30, 1925, progress was made in extending both the country district and the metropolitan services. The department operates a hydroelectric station of 65,000 h.p. at Waddamana, with main transmission lines running south to Hobart and north to Launceston. A further main line is under construction to serve the north-west portion of the state. The Launceston city council is supplied with energy in bulk, but in Hobart the retail supply is in the hands of the hydroelectric department. Apart from the main transmission lines the department operates many lines giving service to country districts. There are 13 miles of 44,000-volt lines, 52 miles of 11,000-volt and 18 miles of 6,600-volt. Further 11,000-volt lines to the extent of 16 miles are now under construction.

The following tabulation gives particulars of the operations of the various branches for the year.

	Bulk Supply
Units generated at Waddamana	284,125,900
Maximum demand at Waddamana, kw.	38,400
Units sold to—	
Hobart District	18,503,670
Electrolytic Zinc Co.	217,540,354
Carbide and Electro Products Ltd.	20,258,000
Launceston City Council	4,914,373
Country District Supplies	553,210
North-West Coast Towns—	
(Generated at Devonport steam station).	533,690
Maximum demands—	
Hobart District, kw.	6,468
Electrolytic Zinc Co.	26,700
Carbide and Electro Products Ltd., ...	2,628
Launceston City Council, ...	1,830
Country District Supplies, ...	471
North-West Coast Towns, ...	360
Total connections, kw.	54,877
Average load factor, Waddamana, per cent	93.4
Highest load factor for any 24 hours, per cent	98.95
Gross revenue	£164,141
Operating expenses	14,288
Administration, etc.	3,364
Gross profit (to profit and loss a/c)	146,489
Hobart District Branch	
Units sold	11,749,972
Maximum demand, kw.	5,423
No. of consumers	11,441
Connected load, kw.	21,958
Motor connections, h.p.	5,435
Gross revenue	£103,995
Purchase of bulk energy	46,553
Working expenses	15,148
Gross profit (to profit and loss a/c)	42,294
Country District Retail Supplies (Derwent Valley)	
No. of consumers	330
Connected load, kw.	623
Motor connections, h.p.	388
Gross revenue	£3,795
Purchase of bulk energy	1,860
Working expenses	519
Gross profit (to profit and loss a/c)	1,415

Profit and Loss a/c (Whole Undertaking)	
Gross Profits from Trading a/cs.	£190,376
Interest on Loans	183,505
Depreciation	25,675
Amounts written off	1,366
Debit Balance	20,170
Total Capital Invested to Date	3,203,760
Accumulated Debit Balance	52,191

SYDNEY MOTOR BUSES

The N.S.W. government proposes to deal with the problem of competition between privately owned motor buses and the state owned tramways and railways by taking over the whole of the motor passenger transport undertakings in the Sydney metropolitan area and vesting them in the railway commissioners. It is estimated that at present the total value of the bus properties in the neighborhood of £750,000. The premier states that if the services are taken over the owners will be compensated and the present employees retained.

TRAM AND BUS COMPETITION

The Electric Supply Co. of Victoria Ltd., which operates tramway and electric supply undertakings in Ballarat and Bendigo, is feeling the effects of motor bus competition with its transport systems in both cities. In Ballarat, before the bus services were brought under regulation, the competition resulted in losses to the company and at the same time prevented the bus owners from making a fair margin of profit. In Bendigo the council is considering the framing of regulations with regard to the motor buses. Mr. P. J. Pringle, the general manager of the electric supply company, has written to the council asking to be allowed to inspect a draft of the proposed regulations. He points out that the tramway and electric supply undertaking is one of Bendigo's most important industries, and that if uneconomic competition with its services is to be allowed an unjustifiable burden will be placed upon the customers of the undertaking, as any loss arising from the competition would have to be made up by increasing the price of the electric supply service to the 4,500 ratepayers who are consumers. In addition the livelihood of the men employed in the tramway undertaking is concerned, as the system could not be run long at a loss even if the resources of the electric supply branch were to be drawn upon to support it. Thus unregulated competition is not in the best interests of the city.

The council is not wholly in accord with the point of view expressed by Mr. Pringle, but it has decided to meet him and discuss the matter early in February.

RAPIDLY INCREASING POWER DEMAND IN NEW ZEALAND

The contract for power development at Arapuni, N.Z., at present being carried out by Sir W. G. Armstrong, Whitworth and Co., provides for a 60,000 h.p. installation to be completed in 1928. Early estimates anticipated that this development would be sufficient to take care of the load demand. The public works department, however, has recently prepared further estimates which show that the demand will be considerably in excess of that for which the 60,000 h.p. development can provide. The ultimate capacity to which Arapuni can be developed is 120,000 h.p., but even this may not be sufficient, and preparations are being made, therefore, to push ahead with the first portion of a projected scheme at Waikaremoana in order to provide another 60,000 h.p. One of the principal power consumers, the Auckland power board, already has a demand of 35,000 h.p.

The first portion of the Arapuni power station, on which work is now in progress, will contain three 15,000-kw. generating units with provision for a fourth. The final station will contain eight similar units. Each unit will be capable of charging 200 miles of 110,000-volt transmission line. Connecting Arapuni with Auckland and the country north of Auckland, there will eventually be five three phase 110,000-volt transmission lines. The first of these has been erected and is being used at present to supply power from Hora Hora at a pressure of 50,000 volts. A 750-kv.a. substation at Bombay gives supply to the Franklin power board. The capacity of this station will ultimately be raised to 5,000 kv.a., and a line will be run to Waikino linking up with the line from the Tauranga council's station at MacLaren's Falls and with the present Waihi line.

LAUNCESTON CITY COUNCIL. ELECTRIC SUPPLY AND TRAMWAYS

During the year ended Oct. 31 last the electric supply department of the Launceston city council made a steady expansion of services. The increase in lighting connections is equivalent to 4,037 30-watt lamps, and an additional 142 h.p. in motors and 554 kw. of heating have been connected. The connections to date total about 14,900 electric horse power. During the year a considerable advance was made with changing over the supply from the 190/110 volts, 50 cycle three phase obtained from the hydroelectric and steam power stations to 415/240 volts, 50 cycle three phase obtained from bulk

supply by the government hydroelectric department. The suburbs of South Launceston and Mowbray, portions of Invermay, West and East Launceston, Inveresk, Newstead and the centre of the city have been changed over.

The tramway department, in common with undertakings in other cities, is feeling the pressure of bus competition, and the revenue for the year ended June 30 last shows only a slight increase over that for the previous year. A scheme was under consideration for extending the services to Killafaddy, but it was finally decided, after conference with the St. Leonards council, to inaugurate a motor bus service to the district instead. The city council, therefore, is putting three buses on the road.

TURBO-ALTERNATOR FOR MELBOURNE CITY COUNCIL

The Melbourne city council has recently had under consideration tenders for the supply of a turbo-alternator to replace obsolete plant at the Spencer street generating station. A machine of 5,000 kw. capacity was called for, but the tenderers were allowed to put forward alternative propositions if they so desired. After careful comparison of prices and performance guarantees the electric supply committee of the council recommended acceptance of the tender of Messrs. C. A. Parsons and Co., England, for a 6,000 kw. machine for early delivery. However, in view of the fact that an Australian tender had been received from Messrs. Thompson (Castlemaine) Pty. Ltd., acting in collaboration with the Metropolitan-Vickers Electrical Co. Ltd., England, the council referred the recommendation back to the committee. The committee has decided to call fresh tenders for the plant, making a provision that the capacity must not be less than 5,000 kw. or greater than 5,500 kw. Tenderers are to be invited to quote for as much of the plant as possible to be manufactured in Australia.

New Publication

Journal of the Technical Instructors' Society of Victoria.—The second number of this quarterly bulletin has been issued. It contains the address of the president, Dr. H. J. Schapper, on the occasion of the first annual conference of the society; a Brief Sketch on the Growth of Technical Education in Victoria, by Donald Clark, chief inspector of technical schools; a paper on Examinations and Examiners, by J. Sarvaas; a paper on Standardisation, by Mr. E. Bartlett, and the programme for 1926.

Radio News

Mr. F. W. Medhurst, the president of the Hobart Radio Experimental Club, has been appointed a life member of the Wireless Institute of Australia.

A 5-kw. transmitter is in course of manufacture for the Queensland government broadcasting station, 4QG. This will replace the $\frac{1}{2}$ -kw. unit at present in use.

A successful installation of wireless telephony on a train has been made in Germany. Excellent communication has been obtained between the train, while travelling at high speed between Berlin and Hamburg, and an office in Berlin. The tariff for the service is to be about 5/- for a three-minute call.

The Marconi Co. announces the conclusion of an agreement with the British postmaster-general, which enables the company to conduct services with nine additional European countries and all foreign countries outside Europe, in addition to four European and United States stations already operating. This will allow the company to proceed with the establishment of a world-wide wireless service.

The British government's new high power transmitting station at Rugby is now in operation. Reports of reception of the signals have been received from America, South Africa, Australia and New Zealand. The wave length is 18,200 metres. In addition to its use for telegraphy, experiments are being made in the direction of utilising the station for telephonic communication with America.

LIGHT WAVES AND OTHERS*

The longest wave on earth, or rather on water, is the tidal wave, which near the equator has a length from crest to crest of about 12,000 miles. The shortest wave commonly known is probably the tiny ripple produced by a light puff of wind on a road-side puddle, with a wave length of perhaps $\frac{1}{8}$ in. Between these two physically visible waves there is a tremendous difference in frequency. But the ordinary electric lamp, in performing its function, covers a still wider frequency range from the sixty cycle electric wave, with length of about 3,000 miles, to light waves, the longest of which has a length of only about one three hundred thousandth of an inch.

Within the range of wave lengths spanned by the electric lamp, between the extremes of electric power transmission and light, lie all the radio waves, the Hertzian waves and the heat or infra-red waves. The wave lengths of the radio waves are familiar to nearly everyone, the Hertzian waves vary from about $\frac{1}{10}$ to $\frac{1}{100}$ of an inch, and the heat waves cover a range of about three hundred to one. Next come the light waves but beyond them are others, viz., ultra-violet rays, X-rays, and finally the gamma rays from radium, two hundred thousand times shorter than light. This enormous gamut of radiation is tabulated in octaves, an octave representing a range in which the wave length is halved. The total range from power transmission to gamma rays represents more than sixty octaves. Of these, less than one embrace all that is ordinarily termed light, from the longest red to the shortest violet. Furthermore, nearly all the energy of radiation received from the sun falls within three octaves, with its maximum within the visual or light range, but extending a short distance into the ultra-violet and further into the infra-red.

THE INVENTION OF THE THERMIONIC VALVE

A considerable section of the scientific exhibit at the British Empire exhibition was devoted to wireless waves. Historically the most interesting exhibit was the collection shown by Dr. J. A. Fleming in illustration of the origin and development of the thermionic valve in wireless telegraphy and telephony. The phenomenon on which thermionic valves are based was noticed over forty years ago by Edison, who found that when he sealed a metal plate in an ordinary electric incandescent lamp between the legs of its carbon filament and heated the filament by a direct current, a small current could be detected between the positive terminal of the filament and the wire that carried the plate, but none between the negative terminal and the plate. By investigations undertaken immediately afterwards, Fleming showed that the effect was connected somehow with the projection of particles from the filament in straight lines, and that these projected particles carried a charge of negative electricity, which they could convey from the filament to the plate, but not in the opposite direction. It was not till twenty years later that this phenomenon, which in the interim had been a matter of merely scientific interest, first received a practical application. Marconi had produced his system of wireless telegraphy, in which waves generated by powerful vibratory currents of electricity in a transmitting aerial

*Extract from Paper by L. A. Hawkins, General Electric Co., U.S.A.

wire generated feeble electric vibrations of the same type in a receiving aerial. No simple and certain means, however, were available for detecting these vibrations in the receiving aerial, and the enormous rapidity of the vibrations, going up to a million per second, prevented the use of devices that had been used for rectifying much slower alternating currents. In 1904 Fleming found that if a metal cylinder surrounding the filament was substituted for Edison's metal plate, the apparatus when placed in the path of the wireless oscillations converted them from alternating into uni-directional currents, and acted in effect as a non-return valve. Professor Fleming's collection carries this invention through the various stages, due to himself and others, by which the thermionic valve has attained its numerous and important applications.—"Engineering."

Telephony and Telegraphy

Provision for 600 additional subscribers has been made at the Albion exchange in the Brisbane metropolitan area.

The P.M.G.'s department has recently accepted tenders for automatic telephone equipments to be installed in Sydney and Adelaide, at prices totalling over £400,000.

An automatic telephone exchange with provision for 900 subscribers is to be erected at Canberra, Federal Territory. The ultimate capacity of the exchange will be 3,000 lines.

At the Unley exchange, Adelaide, a manual satellite of Central, having a capacity of 400 lines, has been installed. This brings the total capacity at the Unley building up to 3,040 lines.

The installation of automatic switching equipment has been commenced at the Gordon exchange in the Sydney metropolitan area. An additional position of 180 lines has been installed at the Waverley exchange.

Since carrier wave working was instituted on the Sydney-Melbourne telephone lines there has been a very marked improvement in service. The average delay in obtaining connection from one city to the other is now only four minutes. There is still room for considerably more traffic than the present channels are carrying.

Arrangements are being made to put the carrier wave system into operation for improving the telegraph facilities between Melbourne and Sydney and Melbourne and Adelaide. In the initial stages four wave lengths will be used on each line, thus giving five channels (including the metallic circuit). Eventually the number of channels will be extended to ten on each line. The work should be completed within a year.

Recent statistics give the percentages of telephones to population in various countries as follow:—United States, 13.1; Canada, 10.4; New Zealand, 8.7; Australia, 4.6; Great Britain, 2.3; South Africa, 0.8.

Plans have been made for considerable extensions to the automatic telephone system in the Melbourne metropolitan area. A new exchange is to be established at South Melbourne and the Canterbury exchange is to be converted to automatic. Later an automatic exchange is to be established at Elsternwick, taking in sections now served by the Caulfield, Windsor, Malvern and Brighton exchanges. A new exchange is to be established at Northcote, and the question of installing one at Preston is under consideration. In addition extensions are to be made to the Brighton, Carlton, Collingwood and Sandringham exchanges.

Trade Notes

Installation and Equipment Ltd., with authorised capital of £10,000, has been formed to trade as electrical engineers, contractors, etc. The first directors include Messrs. F. B. Clapp, H. A. MacDonald and E. H. Flack. The registered office is at 39 Hunter street, Sydney.

Australian Wire and Cable Works Ltd. has been registered in Sydney with capital of £60,000 to carry on the business of manufacturer and dealer in metal wires and cables, etc. The subscribers are E. Campbell, L. G. Rowe, S. G. Rowe, N. Campbell, H. J. G. Henderson, C. J. C. Fuller and E. K. M. Bennett.

New M.E.M. Catalogue.—The Midland Electrical Manufacturing Co. Ltd., England, has just issued a new edition of its complete catalogue. Full information and English prices are given of Kantark fuses and M.E.M. ironclad switch and fuse gear. A special feature is a new range of switches known as the Glasgow-Rex. These switches are built to comply with all important public regulations and are particularly robust. The catalogue is amply illustrated and is very attractively arranged.

Underfeed Stokers.—International Combustion Ltd., of London, with which is incorporated the Underfeed Stoker Co. Ltd., of London, has terminated its agreement with H. Perks, of Melbourne, as representative and manufacturer of Underfeed stokers, "Usco" air heaters, "Usco" ash conveyors, etc., in Australia. It has now entered into an agreement with the Combustion Engineering Co. of Australasia Pty. Ltd., of Stock Exchange Building, Little Collins street, Melbourne, to manufacture under licence these plants for Australasia, and this company will be pleased to give all enquiries prompt attention.

Pulverised Fuel Equipment.—International Combustion Ltd., of Kembla building, Sydney, have issued an Australian bulletin on the Lopulco pulverised fuel system. The publication gives a description of the system, with numerous illustrations, and refers to many installations now in operation in overseas power stations.

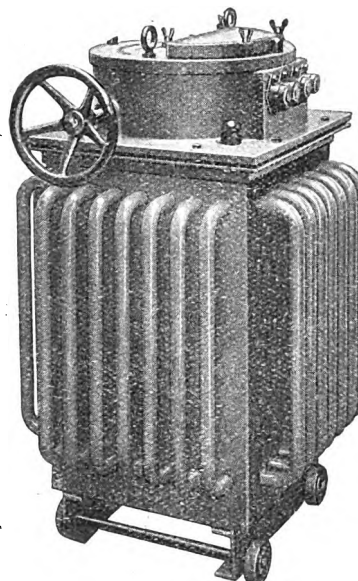
Outdoor Switchgear.—Messrs. Johnson and Phillips Ltd., London, have commenced the manufacture of outdoor switchgear suitable for the control of small quantities of high tension energy. Air break switches, isolating switches, expulsion fuses, choke coils, horn gap lightning arresters and small oil switches for pole mounting are being manufactured for voltages from 3,300 to 33,000. In all the designs high-grade petticoat porcelain pin insulators are used. The designs are carefully worked out and, with good workmanship in the manufacturing, provide very sound equipment.

Electrical Instruments.—Messrs. Siemens (Australia) Pty. Ltd. announce that they have been appointed sole representatives in Australia of Messrs. Elliott Bros. (London) Ltd., the well-known instrument manufacturers. Messrs. Elliott Bros. have been established since the year 1800. A few years ago Messrs. Siemens Bros. and Co. Ltd., of Woolwich, took an interest in the firm and the two companies have for some time been working in close conjunction, hence the present Australian representation. The company manufactures practically every conceivable type of electrical instrument for measuring and testing, in addition to a large number of special lines. Messrs. Siemens (Australia) Pty. Ltd. are carrying considerable stocks of instruments of the ordinary types and will be pleased to give immediate attention to enquiries.

Switches and Standards.—In Great Britain the manufacture, at a reasonable price, of switchgear that will comply with the various regulations and standards is somewhat of a difficult matter. At present there are three separate sets of regulations, viz., the Board of Trade regulations, regulations under the Factory and Workshop Acts, and the rules of the Institution of Electrical Engineers. All these cover equipment and installation work. In addition there are the specifications of the British Engineering Standards Association, for the guidance of manufacturers. The Midland Electric Manufacturing Co. Ltd. has recently been investigating these various sets of rules and standards with a view to discovering the steps necessary in order to make its products comply with all the latest conditions, and its findings have been embodied in an interesting pamphlet entitled, "Switches and Standards." As a result of the investigation some new patterns of ironclad switch and fuse gear have been evolved. These

are the Glasgow-Rex, Memrex and Memette lines, for service in varying current ranges. The rigid conditions under which the designs have been worked out ensure that these switches are of first class quality and are well able to stand up to all reasonable demands in service.

Induction Regulators.—Messrs. Switchgear and Cowans Ltd., of Manchester, England, were the first manufacturers of induction regulators in Great Britain, and they are turning out excellent equipment in this line as a result of their long experience. The S. and C. induction regulators are variable ratio transformers which have been developed in two forms, viz., the boosting transformer and the regulating transformer. The former is primarily for use for feeder pressure regulation, while the latter is especially useful for testing purposes where a gradually varying pressure is required. The regulators, in common with ordinary static transformers embody separ-



Portable Weatherproof Induction Regulator

ate primary and secondary windings. The primary is arranged to rotate with its core, and can be adjusted so that pressure regulation is obtained in gradual variations. The movement is effected by means of a hand-wheel operating through gearing or by means of an electric motor automatically controlled. The smaller sizes of regulator are usually air cooled, and the larger are oil cooled by being immersed in an oil tank equipped with circulating pipes. The illustration shows an oil cooled regulator. S. and C. regulators are at present standardised for working on any primary pressure up to 7,000 volts, and are built in sizes from 1 kv.a. to 150 kv.a. capacity. Further information may be obtained from the Australian representatives of the manufacturers, Messrs. Horrocks, Roxburgh Pty. Ltd., Melbourne.

New Safety Lock Washer.—The Palnut safety lock washer has been placed on the Australian market by the Palnut Co. Ltd., London, through their representative, Mervyn H. Rodney, Box 3025, G.P.O., Sydney. It is made from the finest Swedish oxidised spring steel and possesses many advantages, the principal of which are simplicity of application, safety and efficiency. To apply, it is only necessary to run down the Palnut so that the plain surface makes contact with the face of the nut, after the latter has been sent home, and then give a quarter turn with a spanner. The device can be removed at any time without causing damage to the bolt or screw thread. Irrespective of whether the thread be short or long, and in places where an ordinary lock nut could not be used, the efficiency is unimpaired. The Palnut displaces locknuts, castle nuts, split pins and spring washers and is useful wherever a bolt is employed, especially in cases where vibration is experienced. It can be supplied in any width in sizes from 3/16 in. to 2 in. Samples and quotations for indent can be obtained from the representative.

Truck Type Switchgear.—Messrs. Johnson and Phillips Ltd., London, are manufacturing truck type switchboards for the control of generators, feeders, transformers, motors, etc., operating on single, two or three phase circuits. The panels are constructed in three standard sizes, depending on the voltage and current of the circuits and on the size of the oil switch required. Each cubicle is constructed of heavy angle and channel sections and steel plates, forming a rigid self-contained, totally enclosed structure. The cubicle is made in two parts:—(a) the stationary portion bolted to the floor, containing the busbars, fixed contacts, and cable box, and (b) the truck or moveable portion, containing the oil switch, current and potential transformers, and the instruments which are mounted on the front plate. The truck runs on rail runways which act as guides ensuring alignment of the contacts. When the truck is withdrawn easy access is given to all equipment and wiring on both the truck and the stationary portion of the cubicle. Under this condition the stationary contacts are protected by shrouds which function automatically. An important feature of this type of board is its complete system of interlocks. It is impossible to withdraw the truck with the oil switch closed, or to insert it with the switch closed. It is also impossible to operate the switch unless the isolating contacts are properly engaged. Switchboards of the truck type have many advantages for operation in places where skilled attention is not always available. Messrs. Johnson and Phillips' Australian branches are at 206 Clarence street, Sydney, and 489 Flinders street, Melbourne.

Efficient Street Lighting.—The ideals aimed at in designing a modern street lighting installation are high intensity of illumination, efficient distribution of light and elimination of glare. The problems involved are by no means small, for certain of the factors that must be taken into account act in direct opposition one to the other. Thus the higher the intensity of illumination the greater is the disposition to glare from the source of light. The three ideals, however, may be reconciled very satisfactorily by the use of Holophane street lighting refractors, which direct the light just where

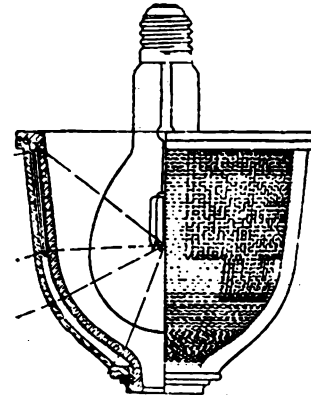


Fig. 1. Holophane Bowl Type Street Lighting Refractor

it is wanted. The refractors are made of transparent glass with prismatic surfaces mathematically designed to intercept and redirect the upwardly emitted rays from the lamp, to distribute the light emitted downwards and to diffuse the beams so as to reduce glare. They consist of two pieces of pressed crystal glass fitting snugly together to form a unit, with the prisms formed on adjacent surfaces so that both the inner and the outer surface of the unit is smooth

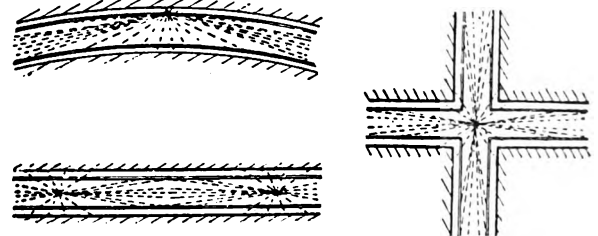


Fig. 2. Action of Various Types of Refractor

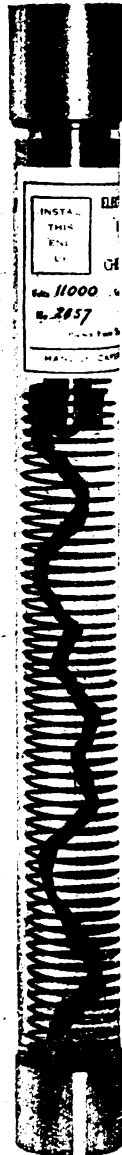
and easily cleaned. There are three principal types: the bowl, the band and the dome, all of which are for use with appropriate lantern fittings. The bowl type is almost closed at the bottom and is made to control the whole light output of the lamp. It is made in four different types of light distribution: symmetrical, two-way non axial (160 deg.), two-way axial (180 deg.), and four-way (90 deg.). These different types are suitable for general illumination, for side mounting giving two-way illumina-

tion along curved streets, for centre mounting giving two-way illumination along straight streets, and for centre mounting at cross roads respectively. The band type is in the form of a band or cylinder with an opening at the bottom to permit a large part of the light to pass direct on to the street surface. This is suitable for use with closely spaced units. The dome refractor is a special design for use inside lightly diffusing globes. It intercepts and re-directs the upward rays only from the lamp. For general service the bowl type refractor may be recommended, the others being more of special purpose units. Fig. 1 shows a part-sectional sketch of a bowl refractor and Fig. 2 illustrates the action of the different types of bowl in street illumination. Further particulars and prices are obtainable from the agents for Holophane Ltd., Messrs. Robert Bryce and Co. Pty. Ltd., Melbourne, Sydney, Brisbane and Adelaide.

Hydroelectric Installation for Scottish Colliery.—In a recent number of the *Electrical Review* a description is given of the new Castle hydroelectric installation of the Balgonie Colliery Co. in Fifeshire, Scotland. This installation makes use of the water of the Leven river in a 56-ft. fall. The water is led to the station by a headrace a mile in length and through two riveted steel pipe lines, both 63 ft. long, 60 in. and 54 in. diameter respectively. The turbines are of the axial entry cased type, working on an effective head of 40 ft. The larger one gives 550 h.p. at 280 r.p.m., and the smaller one 270 h.p. at 400 r.p.m. They are direct coupled to 450-volt d.c. generators which give supply to the company's Milton colliery. The generators were supplied by the English Electric Co., and the turbines by Messrs. James Gordon and Co. Ltd., for whom Messrs. W. G. Watson and Co. Ltd. are Australian representatives. Turbines built by the same firm are in operation at the Mount Lyell Mining and Railway Co.'s works in Tasmania, and at the Jenolan caves and the Hotel Kosciusko in N.S.W. Another set is in course of installation at the Yarrangobilly caves, N.S.W.

The Fynn-Weichsel Motor.—An article in the December number of this journal described the construction, principles of operation and advantages of the Fynn-Weichsel a.c. motor. The machine may be briefly described as a self-excited synchronous induction motor with self-synchronising characteristic. Its principal advantage is that, while it has the excellent starting and power features of the slip-ring induction motor, it runs under load at synchronous speed with leading power factor. Thus it may be used in a power installation in conjunction with ordinary induction motors to give unity power factor for the whole load. In

addition its efficiency is high, it has a high pull-out torque, it does not take a heavy current when starting or when thrown out of step, and the starting equipment is very simple. The first cost is about 10 or 15 per cent above that of an ordinary slip ring motor in the larger sizes and slightly higher in proportion in the smaller sizes. Further information regarding the motor, and quotations may be obtained from Messrs. Warburton Franki Ltd., Melbourne and Sydney.



The Essantee Chemical Fuse.—The provision of adequate protection for branch high tension lines at reasonable cost constitutes quite a problem. The most satisfactory solution appears to lie in the use of high tension fuses. These are made in several types, each having its particular advantages. The Essantee chemical fuse, which has recently been placed on the market, has the advantage that it is instantaneous in action and will clear the line as quickly as a circuit breaker, at the same time effectively suppressing any arc. It is made up of a wire element which melts on overload and allows the fuse contacts to be rapidly drawn apart by a spring. As the contacts fly apart liquid chemical is caused to flow between them, the combined action serving effectively to extinguish the arc. The fuse wire itself is not directly under tension from the spring, neither is it affected by the chemical arc extinguisher, thus the reliability and accuracy of the fuse are not affected by mechanical considerations. The illustration shows a fuse for an 11,000-volt circuit. The tension spring is clearly shown, as also is the flexible lead to the fuse. The spring carries no current and consequently has no tendency to lose its resiliency. The fuses are made in capacities from one to 100 amps and for voltages from 2,200 to 132,000. They may be installed either indoors or outdoors. Further particulars and prices may be obtained from the manufacturers, Electrical Manufactures Ltd., Kembla Building, Sydney.

Vulcanised Bitumen Insulated Cables.—For situations where a large amount of moisture is present, such as the shafts and roadways of many mines, cables insulated with vulcanised bitumen have come into very extensive use of recent years. There is, of course, no more satisfactory and reliable type of electric main than the standard paper insulated lead covered cable,

but under certain special conditions the bitumen cable has advantages due to its waterproof construction and its resistance to chemical action. The great disadvantage of vulcanised bitumen as an insulating material has been its liability to soften under the influence of even slight heat, this softening allowing the conductor to sink out of centre. Messrs. Johnson and Phillips Ltd., the well-known firm of cable makers, have developed an improved vulcanised bitumen compound, under the trade name Elastumen, which has made possible the construction of a cable that will not decentralise under reasonable loading and external temperature conditions. This compound has a high dielectric strength and is tough, resilient and free from liability to crack. Samples of a core insulated with Elastumen have been subjected to compression, by means of weights for 48 hours at a temperature of 170 deg. F. without any decentralisation taking place. While not softening at the high temperature the compound remains pliable at temperatures below freezing point and can be bent without cracking. The dielectric breakdown strength is about 20,000 volts per m.m. Cables insulated with Elastumen

and sheathed with standard vulcanised bitumen have been found to give excellent results in service.

POSITIONS VACANT

Those requiring the services of engineers are advised that a list of men open for engagement is filed by the Editor of this journal. All enquiries will be treated as confidential if so desired.

The municipal council of Coraki, N.S.W., requires an electrical engineer to take control of the local electricity supply. Applications close at noon on January 23. The salary is £350 per annum.

An assistant mechanical engineer is required by the Victorian state electricity commission, and applications are being invited closing January 30. Experience required in applicants is primarily in the design of high pressure boiler and turbine plant and the preparation of specifications. Salary is at the rate of £450 per annum.

Lighting and Power

Beechworth, Vic.—Negotiations are in progress between the shire council and Messrs. Zwar Bros. and Co. for a supply of electrical energy for the town. The firm is increasing its plant by the installation of a 220 h.p. crude oil set. If the demand for the town supply warrants it a further set will be installed.

Bellingen, N.S.W.—It is anticipated that the shire council's electric supply undertaking will be put into operation in March. The plant will consist of Ruston and Hornsby suction gas engines driving G.E. alternators. The distribution system will be 415/240 volts 50 cycle three phase. Mr. R. J. N. Franki is the consulting engineer.

Benalla, Vic.—The state electricity commission will take over the council's electric supply undertaking on April 2. Energy is to be supplied from the north-eastern transmission system at a later date.

Beulah, Vic.—The Karkarooc shire council is asking for authority to raise a loan of £5,000, part of which will be used for repairs and renewals to the electric supply plant.

Blacktown, N.S.W.—Mr. R. J. N. Franki, consulting engineer, is drawing up plans and specifications for an electric supply undertaking covering Wentworthville and Doonside. The estimated cost is £30,000.

Broken Hill, Vic.—The city council is making considerable extensions to the electric supply plant, and has accepted tenders for two 340 h.p. four cylinder and one 90 h.p. two cylinder Vickers-Petters crude oil engines direct coupled to two B.T.H. and one Oerlikon alternators respectively, for running in parallel. There is already a 240 h.p. four cylinder Vickers-Petters engine in commission at the station.

Burradoo, N.S.W.—The electric supply undertaking of the Nattai shire council has been put into operation. Energy is purchased in bulk from the public works department's power station at Port Kembla.

Byron Bay, N.S.W.—The shire council's electric supply undertaking has been put into operation. Energy is purchased in bulk from the Wilson's creek hydroelectric station of the Mullumbimby council. The distribution is carried out at 415/240 volts, 50 cycle three phase a.c.

Carterton, N.Z.—The Wairarapa power board is calling tenders for a 1,000 h.p. standby generating unit for the Upper Kourarau hydroelectric development.

Cheviot, N.Z.—The development of a hydroelectric power scheme for the district is under consideration.

Coff's Harbor, N.S.W.—The Dorriggo shire council has entered into an agreement giving a franchise to Patrick Burke for the supply of electric energy throughout the town.

Cranbourne, Vic.—Enquiries are being made of the electricity commission as to the likelihood of electric supply being extended to Cranbourne, Bayles and Kooweerup.

Davenport, S.A.—Mr. A. W. Murray, of the Southern Electric Power Co., Adelaide, has been appointed consulting engineer to draw up an electric supply scheme for the town. Direct current energy is to be purchased in bulk from the Commonwealth railway department at Port Augusta. Tenders for the necessary equipment and installation work are to be invited shortly. The estimated cost of the scheme is £2,200.

Dorriggo, N.S.W.—The electrical engineer recommends the extension of the shire hydroelectric undertaking to North Dorriggo.

Dundas, N.S.W.—The municipal council is calling tenders for the supply of material for extensions to the electric supply reticulation.

Dunedin, N.Z.—The Otago power board is considering the extension of its activities. Enquiries for power supply have been received from Owaka, Lawrence and Clinton.

Edithburgh, S.A.—The new electric supply undertaking was put into operation on December 22. At present there are 15 consumers but the supply is to be extended to about 55 consumers. The plant is crude oil driven. The price charged for lighting is 1/6 per unit, with a minimum charge of 8/- per month.

Eketahuna, N.Z.—The Tararua power board is raising a loan of £20,000 for extensions to its undertaking.

Ferntree Gully, Vic.—The new electric supply from the mains of the electricity commission has been switched on to Ferntree Gully and Upwey.

Garfield, Vic.—Arrangements have been made for a supply of electricity from the local picture theatre.

Gerrington, N.S.W.—The municipal council is borrowing £4,500 for an electricity supply undertaking.

Hamilton, N.Z.—The public works department has informed the borough council that it must underground its main electric supply lines. This work will involve an expenditure of £6,000. Tenders are to be called for the job.

Hepburn, Vic.—During the six months from June to November, 1925, the Hepburn Springs Electric Supply Co. Ltd. realised a profit of £30 on its operations. The number of consumers is now 97.

Katoomba, N.S.W.—A scheme is under discussion for the formation of a county council on the Blue Mountains, to control electricity and water supplies and other matters of mutual interest to the local councils concerned.

Lawson, N.S.W.—The Blue Mountains shire council is obtaining a report from Mr. R. J. N. Franki, consulting engineer, on the extension of electric supply to Emu Plains and Springwood.

Manunui, N.Z.—The town board is raising loans totalling £5,000 for electric supply purposes.

Maryborough, Vic.—The council is considering making extensions to its electric supply plant in order to meet the increasing demand.

Minyip, Vic.—Mr. A. Pearson has been appointed engineer in charge of the electric supply station in place of Mr. T. B. Wardley, who has resigned.

Moree, N.S.W.—It is proposed to increase the number of street lighting units from 44 to 90, and to increase the candle power of individual units.

Mornington, Vic.—The shire council is raising a loan of £4,000, £500 of which will be devoted to the extension of electric supply to Mount Martha.

Mullumbimby, N.S.W.—The electric supply from the council's hydroelectric station at Wilson's creek, has been switched on.

Mylor, S.A.—The Adelaide Electric Supply Co. has announced its intention of extending its mains to the district in about six months' time.

Opotiki, N.Z.—The Bay of Plenty power board has instructed Messrs. Vickerman and Lancaster to investigate the local demand for electricity, the cost of reticulating the board's area, and the various sources from which power could be supplied.

Ouyen, Vic.—Mr. A. Mathers, of Nagambie, has been appointed engineer in charge of the electric supply undertaking. The council is considering the installation of additional plant.

Rabaul, New Britain.—Messrs. Adams and Cooper, general engineers and garage proprietors, are installing an electricity supply undertaking. It is anticipated current will be switched on early in 1926.

Ringwood, Vic.—Some little time ago the electricity commission took over the electric supply from the municipal council under an agreement providing, amongst others matters, that no increases in charges were to be made to consumers. Subsequently the commission introduced its two part tariff in the district, with the result that the cost of energy to small consumers was somewhat increased. The council pointed out that this was a breach of the agreement, and in consequence the commission has now reverted to the old scale of charges with separate metering for lighting and power.

Ross, Tas.—The council is reconsidering the question of coming into the Midlands electric supply scheme along with Oatlands and Campbell Town. Mr. C. B. Davies, consulting engineer, has been engaged to make a report on the matter.

Roxburgh, N.Z.—The Teviot power board is taking steps to increase the capacity of its hydroelectric station by the installation of a 500-kw. generating set. The aggregate capacity of the two present sets is about 500 h.p. The board is also extending its lines.

Rylstone, N.S.W.—The shire council is calling tenders for works in connection with the electric supply scheme, including a high tension line from Rylstone to Kandos and the supply and erection of the distribution systems in Rylstone and Kandos. Tenders close with the shire clerk, Mr. R. I. Penman, on Feb. 5, 1926.

Sale, Vic.—Since the electricity commission assumed control of the electric supply the number of consumers has increased from 460 to 560 and the maximum demand from 88 to 200 h.p. The butter factory has completely electrified its plant.

Stawell, Vic.—The borough council is calling tenders for a suction gas engine and an alternator for extensions to the electric supply plant.

Takaka, N.Z.—The Golden Bay Cement Co. is negotiating with the Golden Bay power board for bulk supply of electrical energy.

Tauranga, N.Z.—The borough council has informed the Tauranga power board that it is not prepared to discuss the suggestion of selling the McLaren's Falls hydroelectric undertaking. A supply of 1,300 h.p. of electrical energy is now being fed into the public works department's mains from the station. When the second generating unit is installed 2,600 h.p. is to be supplied.

Tumut, N.S.W.—At a public meeting held on January 9, a resolution was carried that the municipal council approach the government with a request that reconsideration be given to the formation of a county council to commence the work of the Tumut river hydroelectric scheme.

Wagga, N.S.W.—Mr. G. B. Lincolne, consulting engineer, has been engaged to report to the council regarding the agreement submitted by the public works department for bulk supply of electrical energy from the Burrinjuck hydroelectric scheme.

A shut down of the electric supply station was caused recently by a wind storm blowing a large tree across the roof of the building and breaking the h.t. feeder lines. Electric supply has been extended to North Wagga.

Wahgunyah, Vic.—The state electricity commission will take control of the electric supply undertaking on Feb. 1. Later energy is to be supplied from the north-eastern transmission system.

Wallaroo, S.A.—The cost of the street lighting service for the town during the year ended Nov. 30 last is estimated at £280. During the same period a loss of £109 was sustained on the total operations of the electric supply undertaking. In view of these figures the council is considering the imposition of a street lighting rate of approximately 3d. in the pound.

West Wyalong, N.S.W.—The Bland shire council has recently completed extensions to its plant at a cost of approximately £6,000. A 350-h.p. Saunders wood fuel gas producer has been installed, supplying gas for the original plant and also for a new 150-h.p. Crossley twin cylinder gas engine. The engine is belt coupled with Lennix drive to a 75-kw. 480/240 volt E.C.C. d.c. generator. In addition a new system of water supply and circulation has been installed. This comprises an underground tank with filter bed, from which water is lifted by two motor driven centrifugal pumps to overhead tanks for supplying the scrubber and engine circulation. Further extensions include 18 ornamental street lighting brackets with 200-watt lamps. Mr. B. A. Beckwith is electrical engineer.

Current Prices for Electrical Supplies

The quotations in this list represent the average retail selling prices ruling in Melbourne during the month of publication. These prices are subject to bona fide traders' discounts. Special rates are obtainable in most cases for large quantities. In general Sydney prices are slightly lower.

Adaptors—

Hardwood	doz.	11/3
Parallel	each	6/6

Blocks—

3 in. round	gross	21/3
3½ in. round	gross	21/3
6 in. x 3 in. rectangular	doz.	6/3
9 in. x 3 in. rectangular	doz.	7/6
6 in. x 6 in. square	doz.	12/6

Bushes—

½ in. ideal metal	gross	7/6
¾ in. ideal metal	gross	7/6
1 in. ideal metal	gross	8/9
¾ in. plain wooden	doz.	1/6
1 in. plain wooden	doz.	1/8
1 in. plain wooden	doz.	2/

Bells and Bell Material—

Bell transformers	each	10/6
1½ volt dry cells	each	3/
Bell wire—1/.029 d.c.c.	1,000 yd.	32/6
1/.036 d.c.c.	1,000 yd.	42/6
1/.029 d.c.c. and i.r.	1,000 yd.	50/
1/.036 d.c.c. and i.r.	1,000 yd.	60/
No. 2 porous pots	each	2/
No. 2 jars	doz.	8/9
No. 2 zincs	each	1/3
Salammoniac	lb.	1/3
2½ in. wood box bells	each	4/6
2½ in. iron box bells	each	4/6
3 in. wood (church gong)	each	18/4
Bell presses	from each	3/9

Pocket Lamp Batteries—

Batteries, pocket lamp	each	1/10
2-cell batteries	each	2/5
3-cell batteries	each	2/8

Ceiling Roses—

	English	Japan
2-plate	doz. 10/5	5/5
3-plate	doz. 13/9	7/6

Connectors—

1-way, porcelain	doz.	2/6
2-way, porcelain	doz.	4/
3-way, porcelain	doz.	5/

Counterweights—

Porcelain	each	2/6
Brass	each	5/6
Shot for same	lb.	6½d.

Casing and Cover—

Best white pine	100 ft.	10/
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Conduit—

	Plain	Screwed
½ in. 100 ft.	8/9	20/
¾ in. 100 ft.	9/7	20/
1 in. 100 ft.	15/	27/6
1 in. 100 ft.	27/6	40/
1½ in. 100 ft.	45/	60/
1½ in. 100 ft.	68/	85/
2 in. 100 ft.	—	135/
¾ in. oval 100 ft.	12/6	—

Conduit Fittings—

	½ in.	¾ in.	1 in.
Grip—Tees	doz. 3/10	3/10	4/8
„ Elbows	doz. 3/	3/	3/10
„ Couplings	doz. 2/3	2/3	2/
Crampets	gross 5/5	5/5	6/3
Saddles	gross 5/	5/	5/5

Conduit Fittings—

	½ in.	¾ in.	1 in.
Screwed tees	doz. 5/5	7/6	
„ elbows	doz. 3/9	5/5	
„ couplings	doz. 2/9	4/	
„ bell mouths	doz. 5/	5/	
„ „ „ 1 in.	doz. 14/10		
„ „ „ 1½ in.	doz. 19/6		
„ „ „ 1½ in.	doz. 27/		

Junction Boxes—

	½ in. & ¾ in.	1 in.
2-way	doz. 10/10	10/10
3-way	doz. 11/3	11/3
4-way	doz. 11/3	11/3

Fuses (Cut-outs)—

	British	Japan
5 amp, anchor type	doz. 10/	5/
5 amp, round chamber	doz. 17/6	8/9
8 amp, round chamber	doz. 20/	12/6
10 amp, oblong	doz. 35/	25/
20 amp, oblong	each —	3/

Holders—

	English	Japan
C/G., S/C. holders	doz. 11/3	8/4
½ in. and ¾ in. holders	doz. 11/3	8/4
Batten holders	doz. 12/6	9/2

Lamps—

	Metal Filament, Vacuum Type	
25 to 250 volts, 20 to 60 watt	each	2/
20 to 250 volts, 100 watt	each	5/
	Gas-filled Type	
20 to 250 volts, 25 to 40 watt	each	2/9
60 watt	each	3/3
75 watt	each	3/9
100 watt	each	5/3
150 watt	each	7/
200 watt	each	9/
300 watt	each	13/
500 watt	each	17/6
750 watt	each	22/6
1000 watt	each	27/6
1500 watt	each	40/

Carbon Filament

All voltages, 5 to 32 candle power	doz.	24/
All voltages, 50 candle power	doz.	42/

Plugs—

5 amp two pin plugs	doz.	27/6
5 amp two pin tops	doz.	12/6

Shades, Opal—

8 in.	doz.	10/
9 in.	doz.	12/6
10 in.	doz.	15/

Switches—

	English
5 amp s.p. pol. brass	doz. 18/3
5 „ s.p. ox. copper	doz. 17/11
5 „ 2-way pol. brass	doz. 30/
5 „ 2-way ox. copper	doz. 33/
10 „ s.p. pol. brass	doz. 37/6
5 „ d.p. pol. brass	doz. 37/6
10 „ d.p. pol. brass	doz. 85/
5 „ s.p. ceiling switches	each 5/6
5 „ 2-way ceiling switches	each 6/6
1 „ ceiling switch and rosette	each 5/6
3 „ American tumbler	doz. 22/6
3 „ s.p. indicating rotary	doz. 24/

Switches—

3	„	s.p. non-indicating rotary	..	doz.	22/6
3	„	2-way rotary	..	doz.	56/3
5	„	d.p. indicating rotary	..	doz.	62/6
10	„	d.p. indicating rotary	..	doz.	75/
20	„	d.p. indicating rotary	..	doz.	150/

Switchboards—

		English	Japan
Single circuit marble 5 amp	.. each	9/9	8/
Single circuit marble 10 amp	.. each	17/6	16/3
Two circuit marble 5 amp	.. each	19/2	15/10
Two circuit marble 10 amp	.. each	25/	22/

Switchboard Frames—

6 in. x 6 in. local make	..	doz.	9/6
6 in. x 8 in. local make	..	each	1/
8 in. x 8 in. local make	..	each	1/3
8 in. x 10 in. local make	..	each	1/6
10 in. x 10 in. local make	..	each	1/8

Tape—

Black adhesive	..	lb.	2/9
Pure rubber	..	lb.	15/

Wire and Cables—

Per 1,000 yd.

1/.044, 600 meg.	..	£7	3	4
1/.064, 600 meg.	..	10	5	0
3/.036, 600 meg.	..	11	15	0
7/.036, 600 meg.	..	20	10	0
7/.044, 600 meg.	..	26	0	0
7/.064, 600 meg.	..	43	10	0

Flexibles—

Per 100 yd.

23/.0076 cotton	..	£2	5	0
40/.0076 cotton	..	2	16	8
70/.0076 cotton	..	3	11	8
110/.0076 cotton	..	4	13	4

Electrical Contracts

COMMONWEALTH

P.M.G.'s Dept., General.—110 tons of 400 lb. per mile and 330 tons of 200 lb. per mile galv. iron wire—Rylands Bros. (Aust.) Ltd. Hard drawn copper wire—233 tons of 200 lb. per mile; 262 tons of 100 lb. per mile; and 20 tons of 150 lb. per mile—British Insulated and Helsby Cables Ltd. Automatic private branch exchange equipment, N.S.W.—Automatic Telephones Ltd. Automatic telephone exchange, Central (Tandem junction, centre), Prospect, Glenelg, Brighton, Henley, Woodville, S.A.—British General Electric Co. Automatic telephone exchanges, Unley and Norwood, S.A.—Western Electric Co. (Aust.) Ltd. Sec. N.S.W. 74.—Automatic telephone exchange equipment, Randwick, Waverley, Gordon, N.S.W. Automatic Telephones Ltd. Sch. N.S.W. 74.—Automatic telephone exchange, Dee Why, N.S.W.—Western Electric Co. (Aust.) Ltd. 45,712 yd. lead covered cable—British Insulated and Helsby Cables.

P.M.G.'s Dept., New South Wales.—1,000 accumulator plates, positive, required for use at the East exchange, Sydney—Gibson, Battle and Co. Ltd.

P.M.G.'s Dept., Victoria.—Sch. N.S.W. 113.—Automatic exchange equipment, Canberra—Automatic Telephones Ltd.

STATES

New South Wales Public Works Dept.—One Vickers-Petters oil engine and Bruce Peebles generator for Jenolan Caves power station—Buzacott and Co. Ltd. Switchgear for Jenolan Caves power station—Australian General Electric Co. Ltd. Supply and delivery of steel towers for Barren Jack hydroelectric development transmission line—A. Ball. Wireless telephone installations for Barren Jack hydroelectric development—Amalgamated Wireless (Aust.) Ltd.

State Electricity Commission of Vic.—6,600 v. and low tension lead covered and armored cable—British Insulated and Helsby Cables, Johnson and Phillips Ltd. Electric lamps—Edison Swan Elect. Co. Ltd. Lead covered 22,000 v. and 6,600 v. single core cable—Johnson and Phillips Ltd.

West. Aust. Govt. Tender Board.—Sch. 195a.—2 transformers, oil for same—Metropolitan-Vickers Electrical Co. Ltd.

GENERAL

Melb. and Met. Tramways Board.—Two motor equipments—Metropolitan-Vickers Electrical Co. Air brake equipments—Westinghouse Brake Co., Australian General Electric Co.

Metropolitan Water, Sewerage and Drainage Board, Sydney.—Centrifugal pumps and electric motors, Briton Ltd..

Waitemata Electric Power Board.—Time switches—National Electrical and Engineering Co.—Forder and Elliott. Street lighting brackets—L. Stericker.

TENDERS OPEN

COMMONWEALTH

P.M.G.'s Dept., General.—Jan. 26—Cord tags, resistances and reactances. March 2—Condensers. March 9—Telephone cord circuit relays, instrument cords. March 16—Ringing generators and polechangers, power board equipment, Adelaide exchange. March 23—Magneto trunk switchboards, telephone switches.

P.M.G.'s Dept., Queensland.—July 6—Automatic telephone exchange equipment.

Works and Railways Dept.—Jan. 25—Switchboard for fuse and case factory. Feb. 8—5-ton overhead electric crane for aircraft depot.

STATES

N.S.W. Public Works Dept.—Jan. 22—Voltmeter. Feb. 1—Two 3-ton electrically driven pedestal jib cranes, steel crossarms, fittings, insulation pins, hooks, pole caps, and accessories. Feb. 8—33,000-volt oil circuit breakers and current transformers.

N.S.W. Railways and Tramways.—Jan. 20—Two 500-kw. rotary converter units. Jan. 27—Two 500-kw. converter units. Feb. 10—Time extended—traction motors, annual stores. Feb. 17—1,500-volt d.c. switchgear. Feb. 24—Electric wires and cables. March 3—11,000-volt ironclad switchgear, 500 impedance bonds, electric car equipments (time extended). March 5—Time extended—Electric power house equipment. March 10—Stokers or pulverised fuel equipment. April 21—Four motor generating sets, switch operating batteries.

State Electricity Commission of Vic.—Jan. 25—Galv. steel transmission towers. March 24—Synchronous condensers and accessory plant. March 29—Transformer and auxiliary apparatus for obtaining neutral point. April 12—Spec. 26/1 turbo-generators, transformers, switchgear, cranes and accessory plant for Sugarloaf-Rubicon hydroelectric scheme.

Victorian Railways.—Jan. 20—Automatic battery charging equipment, fire resisting insulated cable, V.I.R. 3-core cable. Feb. 3—Stranded copper cable, G.I. telegraph wire. Feb. 10—Time extended—Power totaliser and transmitter, total power recorder, and total power indicator, copper graphitic brushes, alternating current power point mechanisms. March 3—Three phase a.c. induction motor. March 10—Aerial telephone cable, d.c. interlocking relays. March 17—Oil switches, 2,200-volt. April 21—Electric overhead travelling cranes, plate bending and straightening rolls and electrical equipment.

GENERAL

Brisbane City Council.—Jan. 20—32 trucks for drop centre tram cars. May 13—Special trackwork for tramway shed.

City Electric Light Co. Ltd., Brisbane.—March 22—H.T. porcelain insulators.

Geraldton Municipality, West. Aust.—Feb. 9—Two 110-kw. crude oil engines.

Hobart City Council.—Feb. 8—Electric motor equipment, three air brake equipments for tram cars.

Melbourne City Council.—March 8—Totally enclosed armored type switchgear. April 7—2,000 kw. rotary converter, etc., switchgear, and a.c. control panels. April 28—2,000 kw. rotary converter, d.c. switchgear and accessories and a.c. control panel.

Metropolitan Water, Sewerage and Drainage Board, Sydney.—Jan. 28—Two 500 b.h.p. motors, starters and spares.

Rylstone Shire, N.S.W.—Feb. 5—Electricity reticulation. **Stawell Borough Council, Vic.**—Jan. 20—Suction gas engine and generator.

Swan Hill Shire Council, Vic.—Jan. 23—3 automatic voltage regulators.

Sydney City Council.—Feb. 1—Steam turbo-alternator plant, automatic reclosing equipments, for H.T. feeder switches. Feb. 8—L.T. underground cables, house service boxes and fuses. Feb. 15—Transformer tanks. Feb. 22—Power house switchgear, steam raising plant (time extended).

Winton Shire Council, Q'ld.—Jan. 25—Generating plant and equipment for town electric supply.

NEW ZEALAND

Auckland Electric Power Board.—Feb. 8—Overhead cotton covered cable. Feb. 22—Cut-outs.

Hastings Borough Council.—Feb. 1—500 b.h.p. Diesel engine, and alternating current generator.

Otago Harbor Board.—Jan. 29—Two 60-h.p., one 30-h.p., one 7½-h.p. motors, 25-kw. generator ammeter, control drive and sprockets.

Public Works Dept.—Jan. 19—50,000-volt switchgear, section 141, synchronous condenser, section 176, 110,000-volt switchgear. Jan. 26—50,000-volt switchgear, section 139; 11,000-volt switchgear; four 4,000-kv.a. transformers, 50,000 v. lightning arresters. Feb. 9—Section 180, Mangahao, induction regulators. Feb. 16—Outdoor switchgear, Waikato scheme, substation transformers, Arapuni scheme. March 2—Section 190, Lake Coleridge, 33,000-volt switch and protective apparatus. Section 150, Arapuni, synchronous condenser and transformers. March 23—Section 125, Arapuni, 22 kv.a. switchgear; section 154, filter presses and testing equipment. April 6—Section 133, Arapuni, storage battery, motor, generator and switchboard. April 23—Section 158, Arapuni, 11,000-volt, metering equipment and switchgear.

MUNICIPAL COUNCIL OF SYDNEY.

STEAM RAISING PLANT

TENDERS will be received by the undersigned until 3 p.m. on the 8th February, 1926, for the SUPPLY and DELIVERY of STEAM RAISING PLANT in accordance with Specification No. 964.

SPECIFICATIONS and full particulars may be seen at the Office of the Construction Engineer, Electricity Department, Town Hall, Sydney, and copies may be obtained from the same Office by the payment of the sum of ten shillings and sixpence (10/6) direct into the City Treasury, Town Hall, Sydney, which sum will be refunded upon the receipt of a bona fide tender.

The lowest or any tender not necessarily accepted.

TENDERERS please note that they must pay their cash deposit direct into the City Treasury, Town Hall, Sydney, and NOT enclose it with their tender, otherwise their tender will be rejected as informal.

W. G. LAYTON, Town Clerk.

Town Hall, Sydney, 18th September, 1925.

SHIRE OF GUNDAGAI

ELECTRICITY SUPPLY WORKS

Tenders are invited for the construction of these works, as follows:—

Section I.—About 1,000 yards 6,600 volt Transmission Line and the Reticulation of the Town.

Section II.—Substation and Equipment thereof for an output of 100 kv.a. with spare transformer.

The Specification and Drawings may be inspected at the office of the Council's Consulting Engineer, Mr. William Corin, M.Inst.C.E., M.I.E.E., etc., 28 O'Connell Street, Sydney, from whom also two copies of the Specification with one set of Drawings may be obtained on paying a deposit of Two Guineas (£2/2/-) which is returnable upon receipt of a bona fide Tender. Additional copies of the Specification may be obtained on payment of Half a Guinea (10/6) a copy and additional sets of Drawings at a Guinea (£1/1/-) a set.

Sealed Tenders endorsed "Tender for Gundagai Electricity Supply Works" are to be addressed to the Consulting Engineer as above and are to be lodged in his office not later than 4 p.m. of Monday, February 8, 1926.

A. J. BROWNING,
Shire Clerk.

Gundagai, N.S.W.
January 13, 1926.

SHIRE OF RYLSTONE

ELECTRICITY RETICULATION.—TENDERS are invited and will be received up to Friday February 5, 1926, for:—

- (a) Supply and Erection of Distribution System, Kandos town.
- (b) Supply and Erection High-tension Transmission Line, Kandos to Rylstone.
- (c) Supply and Erection Low-tension Distribution System, Rylstone town. Three contracts.

Copies of specifications, etc., can be had on payment fee 21/- each, which will be refunded on receipt bona fide tenders. Further copies obtainable at 5/- each, which will not be refunded. Conditions of tendering are supplied with each set of specifications.

R. I. PENMAN,
Shire Clerk.

P.O. Box 18, Rylstone, N.S.W.

SHIRE COUNCIL OF WINTON, QUEENSLAND

ELECTRIC SUPPLY UNDERTAKING

Tenders are invited up to 12 noon on MONDAY, JANUARY 25, 1926, for various Plant and Equipment in connection with the Electric Supply Undertaking at Winton, Queensland, as follows:—

- Contract No. 1.—Suction Gas Electric Generating Plant.
- Contract No. 2.—Main Switchboard.
- Contract No. 3.—Wooden Poles and Crossarms.
- Contract No. 4.—Cables, Insulators, Lightning Arresters, Meters, Service Cut-outs, Portable Instruments, etc.
- Contract No. 5.—Street Lighting Fittings and Lamps.

Copies of Plans and Specifications may be perused at and obtained for a fee of 5/- per copy of each Specification (not returnable) from the offices of the Council's Consulting Engineer.

A. E. HARDING FREW, B.E.,
T. and G. Building,

Queen street, Brisbane.

Neither the lowest nor any tender will necessarily be accepted. Canvassing by the tenderers of any member of the Council of the Shire of Winton will be considered a disqualification.

By order,

J. T. WILSON,
Shire Clerk.

FOR SALE

1 Premier Gas Engine, 450 B.H.P.; 2 Mond Gas Producers, each 550 H.P. for working Producers alternatively; 2 Roots Blowers, one steam, one electrically driven. Number of spare parts. Particulars and Photos of Plant.

J. SCOULAR, Consulting Engineer,
G.P.O. Box 3221 P., SYDNEY, N.S.W.





Editorial





THE ELECTRIC STOVE AT A DISADVANTAGE

A good deal has been heard lately about the great advances made in the use of electricity for cooking. The annual reports of many electric supply undertakings record large increases in the number of electric stoves installed, which is matter for congratulation. But while optimism is quite justified and the taking advantage of every opportunity for publicity is fully warranted, the other side of the question must not be lost to sight. Food for thought may be found in recent expressions of opinion on the subject of electric cooking.

At Wagga, in New South Wales, the municipal council operates both a gasworks and an electric supply undertaking. When the electric supply was inaugurated it was believed that gas would drop out of general use, therefore no provision was made for future extensions to the works. But experience has proved otherwise. The percentage of consumers using electricity for cooking is extremely small, while the use of gas stoves has increased to such an extent that the council is now faced with the necessity for extending the gasworks to meet the demand. Certainly no particular effort has been made to encourage the electrical cooking load, nor has there been any endeavor to increase the use of gas. The plain fact is that a gas stove is so much cheaper than an electric stove that the latter is usually dismissed on the score of initial expense.

A request has been made recently on behalf of federal public servants for the establishment of a gas supply for cooking purposes at Canberra. There is already an electricity supply at the federal capital, and it is stated that electric cooking has received consideration. It is also reported that enquiries made recently in Melbourne concerning the extent to which electric ranges are in use in homes, hotels and restaurants reveal that electricity is used very sparsely and that gas is generally favored. This is quite natural. Electric cooking is a comparatively recent development, and, as yet, has made little headway. The great majority of people do not understand or appreciate its tremendous advantages. Some of the electric supply authorities are trying to develop the electric range load, but the considerable difference in price between an electric and a gas stove is a serious obstacle. It is useless to impress upon the prospective consumer the lower running cost of

electricity in the kitchen as against gas when he absolutely cannot afford the first cost of the electrical equipment. This has been a strong factor in the poor development of electric cooking in the large cities, and it looks as if electricity will lose a big opportunity at Canberra unless prospective consumers can be shown a more reasonable proposition than has been demonstrated in the past.

A further example of the effect of the present high prices of electrical cooking equipment is afforded in connection with the township established by the Victorian electricity commission at Yallourn. The town houses the employees on the brown coal field and at the generating station of the commission. Here, if anywhere, should be an opportunity for demonstrating the advantages of domestic electrification. But the houses have been equipped throughout by the commission with wood-burning ranges. Electric stoves could not be installed because the cost was out of all reason as compared to the cost of the houses.

The present position is most regrettable. The electric stove is an implement for serving the community, for assisting in the elimination of drudgery in the house, and yet it is inaccessible to the great majority. It is of no use saying that prices cannot be reduced, for they can. When the automobile first came into being it was considered exclusively a luxury and toy for the rich. Now a car is looked upon almost as a necessity, and is within the reach of the man of quite moderate means. Close study of manufacturing and selling methods has effected this change. If revolutionary price reductions can be effected in the one case, surely they are possible in the other. Of course, it is said that if a householder can afford a car he should be able to buy a stove. This is true and goes to emphasise the extent of the field yet undeveloped even under present conditions. But electric cooking should be available to every home wherein gas is now used, and until that is the case the electrical industry is not doing its duty to the community.

TRAMWAY LOSSES

There is scarcely a tramway undertaking in Australasia that, at the present time, is not operating at a loss. In most cases the unsatisfactory financial balances are ascribed to the high rates of wages paid to employees and to the competition of other transport services,

notably motor buses. Naturally, under the circumstances, the administrations of the various undertakings come in for a good deal of blame for the losses, whether or not there are just grounds for this. In Melbourne and Sydney trams are under the control of the state governments. The Melbourne undertaking is administered by a board and the Sydney system by the railway commissioners. In each case the government is professing itself dissatisfied with the tramway administration and is proposing to make alterations. Curiously enough, however, the directions in which the respective governments are contemplating movement are directly opposite. In New South Wales it is considered that all will be well if the control of the tramways is removed from the railway commissioners and placed under a board, while the Victorian government appears to have a leaning towards abolishing the Melbourne and metropolitan tramways board and placing the system under the administration of the railway commissioners.

This contradiction of opinions does not augur well for the future of either undertaking. Granted that the present administrative systems do not work altogether satisfactorily, it is obvious that little will be gained by a complete change on the lines proposed. The facts of the case are plain: the continual rise in wages is a general tendency in all industries, and this is bound up with the increase in the cost of living and is a matter of very wide significance. The bus competition has grown up because there was a need for improvement upon the services given by the tramways, although there is doubt whether the buses do give better service than the trams. Unfortunately these two factors, the tendency of wages to rise and the competition of the buses, place the tramways upon the horns of a dilemma. Any increase of fares to meet higher wages means giving less service value to the public, and consequently drives prospective passengers to more extensive use of the competing services. If wages are to remain at the present rates, the only hope for a reduction of costs lies in scrupulous economy in man power, such as the elimination of dead-heads on the administrative and operating staffs. There is, however, a possibility of wages being somewhat reduced, as most of the tramway undertakings in Australia are at present combined in an application to the arbitration court for a fresh log of wages and conditions for employees.

The matter of countering bus competition lies right in the hands of the tramway undertakings themselves. In most cities municipal or state regulations have been introduced preventing irregular running of buses and pirating of passengers. Therefore the whole question is, "Which system can provide the best service?"

There is no doubt that the best system will win in the end, and there is also no doubt that in a great many cases the trams can give services far superior to the buses. It will be an arduous fight for the trams, for public opinion is at present strongly inclined to favor the competing services. The main point to keep constantly in view is that public sympathy counts for everything. The way to gain this is by seeking constantly to improve services, by remembering that adequate publicity is necessary to get the community interested in the business, and by endeavoring to keep in close touch with, and anticipate the needs of, the travelling public.

As far as reorganisation of administration is concerned it appears that the needs of the situation will be best met by having the controlling bodies comprised of men of proved technical and financial experience in tramway operation, acting in conjunction with elected representatives of the people who use the tramways, i.e., representatives of the metropolitan municipalities.

DANGER WITH ELECTRICAL APPLIANCES

At a recent meeting of the Professional Fire Brigade Officers' Association, held in Melbourne, a paper on "Electrical Fires" was read by Mr. W. H. Stock, electrical officer of the Melbourne fire brigade. The lecturer pointed out that domestic electric appliances not equipped with automatic protection against overheating are potential causes of fire, owing to the carelessness of the users in leaving them switched on. The statement is quite correct, but, unfortunately, newspaper reports of the lecture have made a great feature of the danger without stressing the contributory carelessness on the part of the users. As has been pointed out before in these columns, such reports can do a great deal to retard the progress of domestic electrification by raising unjustifiable fears in the minds of prospective consumers. Small domestic appliances are not dangerous when used with ordinary care. Certainly it would be better to give protection against carelessness, but the costs of thermostatic protective devices have hitherto been such as to preclude their general use. The number of instances where domestic appliances have caused fires is extremely small in comparison to the number of appliances in use. It is a very great pity that statements which are damaging if not qualified should be allowed to appear from time to time in the daily press, as they tend to hinder the proper development of electricity in domestic service.

Notes and Personals

Mr. A. Shrimpton, chief telegraph engineer, New Zealand, is due to retire at the end of March after a total service of 42 years.

Mr. A. Kirk, son of Mr. A. E. Kirk, manager of the Aberdare Extended Colliery, Cessnock, N.S.W., has been appointed electrical inspector of mines.

Mr. C. Ludowici has been re-elected chairman of the New South Wales state committee of the Australian Commonwealth Engineering Standards Association.

The English Electric Co. of Australia Ltd., Sydney, has been placed on the British admiralty list of firms possessing adequate facilities for naval repair work.

Mr. H. R. Forbes Mackay, general manager of the electricity supply department, Sydney city council, at present in England in connection with tenders for the Bunnerong power station, is due back in Australia early in May.

Mr. A. H. L. Gibson, of Noyes Bros. (Melb.) Pty. Ltd., sailed recently by the Orvieto on a business trip to Europe and America. He expects to be away for somewhat over twelve months.

Mr. E. Stroud, chief illuminating engineer of Holophane Ltd., London, is making a business tour of the principal Australian cities. While he is in the Commonwealth he intends giving a series of lectures on scientific illumination.

Mr. T. E. Burrows, chief engineer for harbors and drainage, public works department, N.S.W., has been recommended to advise the Sydney city council in the construction of the circulating water tunnels for the new power house at Bunnerong.

Mr. R. J. Hall has joined the electrical staff of Messrs. Coates and Co. Pty. Ltd., who have recently been appointed representatives in Victoria and New South Wales for the Lancashire Dynamo and Motor Co. Ltd., associated with the Crypto Electrical Co. Ltd.

Mr. T. L. Moffat, secretary-treasurer of Moffat's Ltd., stove manufacturers, of Weston, Canada, made short sojourns in Sydney and Melbourne recently during the course of a business tour through New Zealand, Australia and South Africa. He is accompanied on his trip by Mr. T. L. Moffat, junr., and is making enquiries into the possibilities for domestic electrification in the countries visited. The firm of Moffat's Ltd. has been established in the stove making industry for 35 years, and the name is known in almost every part of the world. While in New Zealand Mr. Moffat visited the New Zealand and South Seas Exhibition at

Dunedin, and he was considerably surprised at its extent. The undertaking reflects great credit upon the people of the Dominion in general and the inhabitants of Dunedin in particular. Mr. Moffat is very gratified at the courteous reception extended him by the electrical engineers with whom he has come in contact during his tour. He has discussed matters pertaining to the development of the domestic load with the executive officers of several electric supply undertakings and he is grateful for the facilities for obtaining information which have been placed at his disposal.

The Auckland power board is carrying out considerable improvements to the street lighting of the city by replacing the old lighting units with gas filled lamps, in candle powers from 100 to 600, operated on the series system. The alterations involve a considerable amount of work, which is being carried out under contract for the city council.

The government of the Federated Malay States has signed a concession under which rights are granted to Sir W. G. Armstrong, Whitworth and Co. Ltd. to develop a hydroelectric scheme on the Perak river in the state of Perak. The power so obtained will be applied principally in the development of the Kinta valley and neighboring tinfields, and in cheapening the cost of production in that area.

The act passed by the New South Wales parliament, under the Fuller administration, for the licensing of electrical contractors has not yet come into effect. A board was appointed and regulations were drawn up and sent to the local government department for gazettal. Since the change of administration, however, nothing further has been done and the machinery created under the act for regulating the quality of electrical installation work is prevented from operating. If the present regulations are not acceptable to the government they should be referred back to the board, but it is not fair either to the reputable contractors or to the public that matters should be allowed to rest as they are.

EFFECT OF TWO PART TARIFFS

On Jan. 1, 1925, the Victorian electricity commission introduced two part, one meter tariffs for domestic electric supply in all areas wherein it controlled the retail distribution. Existing consumers were permitted either to remain under the old two meter tariffs or to change over to the new system, but all new connections were to be made under the one meter system. The commission has just issued a statistical statement showing the effect of the two part

tariff. During the first six months 1,400 consumers voluntarily changed over on to the new tariff, and at the end of the year about 50 per cent of the connections in the whole of the districts supplied were on the one meter system. In some districts the percentage of one meter connections was over 70, and it is confidently expected that during the next year the total percentage will rise to at least 75.

The two part tariffs were introduced with a view to encouraging the use of electricity for domestic power and heating purposes, and the statistics go to show that they have had a considerable degree of success in this direction. During the last year the new installations of domestic electrical apparatus were as follow: Irons, 2,825; kettles, 217; grillers, 121; stoves, 85; toasters, 45; vacuum cleaners, 44; sewing machine motors, 40; urns, 15; teapots, 5.

PRESERVATION OF POLES

The Thames Valley power board, N.Z., has initiated experiments with a view to ascertaining the most suitable available timber for power poles and the best preservative treatment. Sample poles to the number of 103 have been erected in a patch of sandy soil, set to a depth of five feet, nine feet apart. Six different species of Australian eucalypt, New Zealand grown, are being tested, and 12 different methods of preparation are being tried out. Some of the poles were placed in the ground without any treatment, and the remainder have been treated in groups as follows:—One coat of hot preservative No. 1 brushed on hot; two coats of hot preservative No. 1 brushed on hot; one coat of hot preservative No. 2 brushed on hot; two coats of hot preservative No. 2 brushed on hot; one coat of hot creosote brushed on; two coats of hot creosote brushed on; dipped once in hot creosote; butt charred and no other treatment; butt charred and dipped in hot creosote; brushed with hot tar; butt charred and dipped in hot tar.

It is considered that at least five years will elapse before any idea of the comparative value of the various treatments can be obtained. As further time passes the value of the experiment will become more apparent.

BRISBANE TRAMWAY EXPANSION

The Brisbane city council, on the recommendation of the tramways manager, Mr. G. R. Steer, is about to call tenders for 20 car bodies and underframes for cars of the drop centre type. During 1925 24 new cars were added to stock, and 29 more are to be delivered within the next six months, but still more are needed to give adequate service. Since the council took over from the Brisbane Tramways Co. it has been endeavoring to alleviate the serious overcrowd-

ing that was taking place during the peak periods. To what extent this has been done is shown by statistics which reveal that the traffic has increased by 15½ per cent during the last three years while the carrying capacity of the rolling stock has increased by 37 per cent. Not only are new cars being provided but the cars are considerably larger than those which the company was operating.

There is still, however, considerable room for improvement. Unfortunately the tramway undertaking has been placed at a disadvantage by the intensification of peak loading consequent upon the closing of shops at 5.30. This necessitates more cars for a limited period in the evening than would otherwise have been the case. But the arrears are being overtaken and when the new rolling stock is installed the tramways should be in a position to adequately serve the transport needs of the city.

SYDNEY COUNCIL'S NEW POWER STATION

Matters are not yet quite clear in connection with the preliminary arrangements for the erection of the new power station at Bunnerong for the Sydney city council. The site is crown land and there appears to be some difficulty in regard to the lease. Up to the present the council has only been able to obtain a tenure of 28 years, this being the unexpired portion of the lease held by the present tenant. It is contended that, in view of the enormous capital expenditure contemplated, the council should have either the freehold or a 99 years' lease of the property. Work of a preparatory nature has already been commenced on the site, but there is no assurance of the longer tenure being obtainable. The actual location of the power house building has not yet been decided upon, and until this is done the preparation of plans is held up.

LARGE VARIABLE VOLTAGE TRANSFORMERS

The Westinghouse Electric and Manufacturing Co. has recently supplied to the Philadelphia Electric Co. six 20,000 kv.a. single phase variable voltage transformers, to constitute two three phase banks stepping up from 13,800 volts delta to from 69,000 to 76,000 volts star. There are four steps for varying the voltage, embodied in a tap changing device designed for changing voltage under full load without shutting off the power or interfering with the transmission system. The transformer tanks are 15 ft. high and 9 ft. 5 in. in diameter. The tap changing mechanism is mounted in a large steel housing attached at the top of the tank. The transformer banks are being installed at the Richmond power station as part of the first two units of what will ultimately be eight 50,000 kv.a. generating and transmission units.

Energy Loss in Dielectrics—II.

By M. C. Timms.

Formulae

Before discussing the actual procedure of testing, some reference to the most readily applied formulae will be of interest. The general formula

$$W = I.V. \cos \phi$$

becomes in the present case

$$W = \omega K.V.^2 \cos \phi \quad (7)$$

where $\omega K.V.$ represents the charging current and $\cos \phi$ the power factor of the dielectric. The "loss angle" or "phase angle" θ being $90 - \phi$, $\cos \phi = \sin \theta$. Thus formula (7) becomes

$$W = \omega K.V.^2 \sin \theta \quad (8)$$

For very small angles $\sin \theta = \tan \theta$ so that for small values of θ formula (8) can be written.

$$W = \omega K.V.^2 \tan \theta \quad (9)$$

As already noted the value of $\tan \theta$ is readily obtained by the Wien bridge, formula (4). K

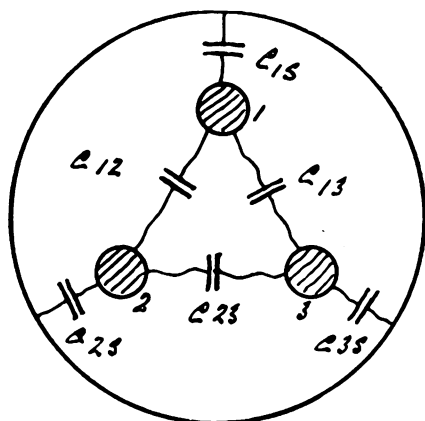


Fig. 7

also can be calculated by formula (1). Thus it is clear that by the aid of the Wien bridge and using formulae (1), (4), and (9) the dielectric loss in watts may be readily determined at any voltage or frequency, provided the test is made at that frequency and approximately the required voltage. Formula (9) has a special advantage in that should the condenser C have a solid dielectric and appreciable phase angle, the tangent of the latter added to that of the cable obtained by formula (4) will give a corrected value of $\tan \theta$ to insert in formula (9).

Capacity of a Three Core Cable

Three core cables being far more generally in use for energy distribution than any other type, these will be given special consideration. The capacity of a three core cable may be represented by a system of condensers as in Fig. 7. Assuming cores 1 and 2 under test

it is desired to measure the loss in C_{12} . For this purpose core 3 is connected to sheath, short circuiting C_{35} . The resulting network is shown in Fig. 8. The core/core or wire/wire capacity is represented by C_{12} . Core 1 has capacity to sheath $C_{15} + C_{13}$, while core 2 has total sheath capacity $C_{25} + C_{23}$.

The total loss, W , in a three core cable is given by

$$W = 3W_w + W_s$$

Where W_w is loss between any pair of cores, that is in C_{12} , and W_s is loss between three cores and sheath, or in $C_{15} + C_{25} + C_{35}$. In order to calculate W , then, two tests are required, i.e., W_w and W_s must be separately determined.

High Voltage Bridge

The principal of the modified Wien bridge as arranged by Mr. Rosen for high voltage testing is shown in Fig. 9. The secondary of the step-up transformer is connected across the ratio arms A and B. The resistances in these arms

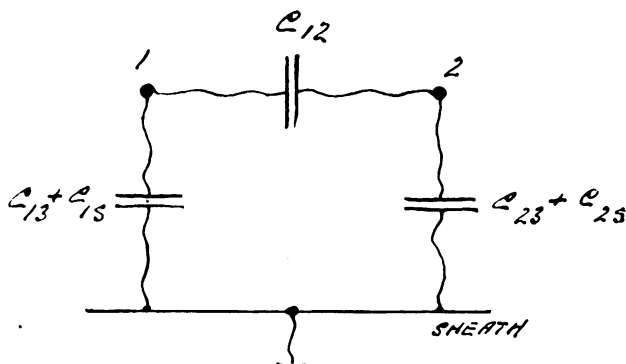


Fig. 8

are specially constructed, sufficiently non-inductive, and oil immersed. A has a value of 500,000 ohms, while B is 5,000 ohms; the ratio A : B is therefore 100 : 1. As a consequence of this high ratio the voltage is concentrated across the condenser under test while the d.p. across the standard C amounts to a few hundred volts only. Thus ordinary mica condensers can be used, and the adjustable arms of the bridge can be handled with safety. The detector, T, is a vibration galvanometer which, by means of a change over switch, may be applied either across the main or auxiliary bridge as required.

Fig. 10 shows the bridge connected to a three core cable in order to test C_{12} . Core 1 is connected to the high potential terminal, E, and core 2 to terminal F. By the balance of the auxiliary bridge, F is brought to earth potential so that $C_{25} + C_{23}$ becomes ineffective.

Core 3 is connected to the sheath, which is earthed. The resulting sheath capacity of core 1, that is $C_{1s} + C_{13}$, thus takes up the function of K^1 , the high voltage arm of the auxiliary bridge. It will thus be seen that C_{12} only is effective in the main bridge and its losses alone are measured.

When testing cores/sheath the three cores are bunched together and connected to E, while the sheath is lightly insulated, as by coiling the cable on a dry wooden drum. A spare length of cable capable of withstanding the voltage is used to form K^1 .

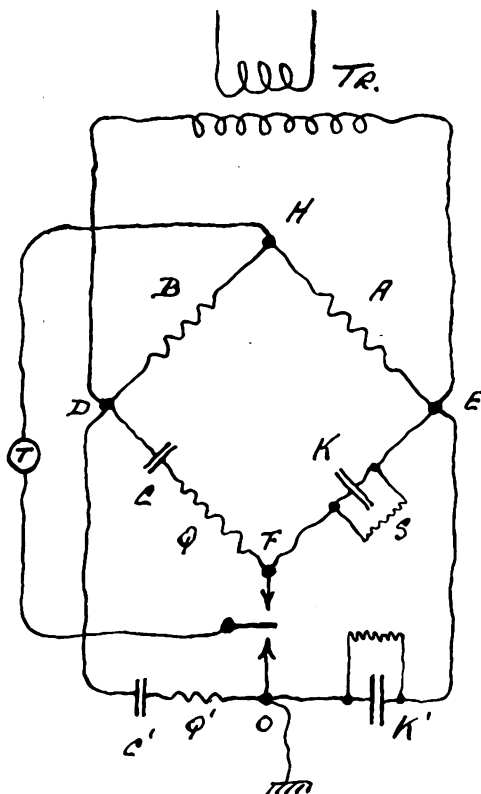


Fig. 9

The two tests here described are sufficient to provide a full knowledge of the losses in a three core cable, as set out in the preceding section.

Notes

(1) When it is desired to measure the core to sheath losses of a single conductor cable the same procedure should be followed as when testing cores to sheath in a three core cable.

(2) Should the sheath of a cable to be tested be permanently earthed, as when submerged in water or buried underground, the procedure outlined for the cores/sheath test cannot be followed precisely. The bridge described may be employed, a preliminary balance being obtained on the auxiliary bridge with the cable disconnected to compensate for the leads, etc.

The cable is then connected up and its losses alone are balanced on the main bridge.

(3) The sensitivity of the vibration galvanometer is very greatly increased if the instrument is connected to the bridge by a step-down transformer. The use of a suitable transformer will provide all the sensitivity required for the most accurate testing. By this means the vibration galvanometer can be made the equal of an alternating current galvanometer without the attendant complications of the latter.

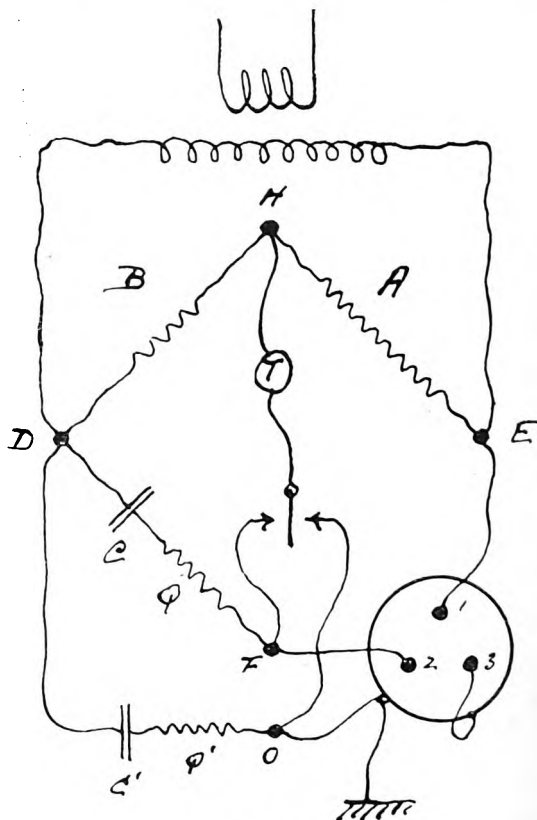


Fig. 10

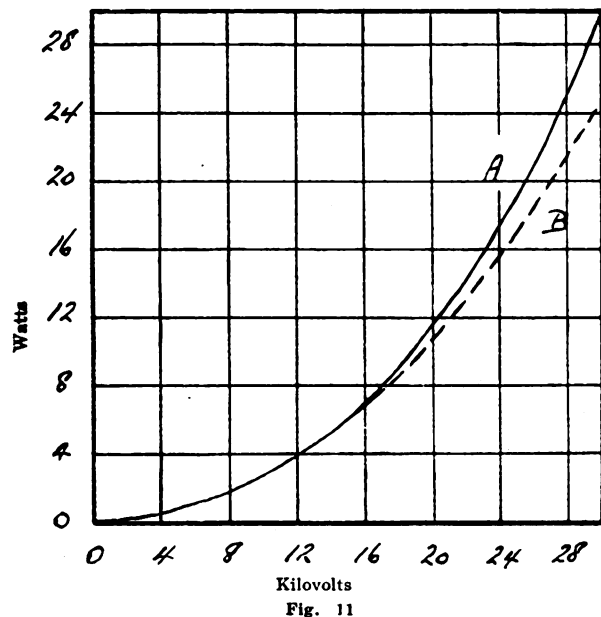
(4) The connections shown in Fig. 10 will, as stated, bring core 2 to sheath potential. Thus the maximum voltage is limited by the safe core/sheath voltage of the cable. In the case of a cable insulated for earthed centre operation the maximum safe test pressure will be limited to well below the maximum allowable core/core voltage.

(5) The results of very careful tests by both bridge and wattmeter measurements show that the discrepancies between results from the two methods are no more than are to be expected from unavoidable experimental errors.

(6) Referring to Fig. 10, should the cable break down, the full voltage would be impressed across the standard condenser, C. To guard against this danger the points F and D are

connected to earth through protection gaps which break down at about 450 volts.

(7) Other high voltage bridge methods have been used; notably a special arrangement by the Standard Underground Cable Co., of U.S.A. This device employs two sources of e.m.f., one high for the cable under test and one of moderate value across the balancing arms. The point of junction of the two is earthed. No Wagner connection is employed. An alternating galvano-



meter is used. This arrangement is exceedingly ingenious and very safe, but in the estimation of the writer it has no advantages over the arrangement shown in Fig. 10, while its range of application is much more limited.⁸

Appendix

It has been noted in the foregoing that when a certain voltage gradient is exceeded the leakage, G , has a component dependent upon the voltage, in addition to A and ωB . Under such a condition the leakage will increase with the voltage, and the energy loss will no longer be proportional to V^2 , but will increase at a greater rate.

Fig. 11 shows the actual losses in a certain cable at various voltages from 1,000 to 30,000, curve A . Curve B shows what the losses would be were they dependent only upon V^2 , taking the loss at 1.0 kv. as a basis. The divergence between the two curves, commencing at about 15 kv., is probably due to the setting up of corona at this voltage; and it is possible that 15 kv. is the maximum voltage at which the particular cable should be operated in order to obtain uninterrupted service for an indefinite period.

The voltage at which internal corona is set up depends on the potential gradient and on the thoroughness with which air has been expelled from the dielectric. It would seem that the voltage, representing a certain potential gradient, at which the two curves diverge should be taken as a true measure of the dielectric strength of the insulating material.

The following table is an example of an actual test on a length of 22 kv. three core cable designed for operation with an earthed centre point.

Voltage ÷ 1,000	C mfd.	Q ohms	ωCQ	$\tan \theta$	Loss, Watts
12.7	8.103	3.4	0.0086	0.0096	39.5
22.0	8.117	4.17	0.0106	0.0116	143

The value of Q includes an allowance for the resistance of the leading wires from the test room to the cable.

The difference between ωCQ and $\tan \theta$ represents the correction for the phase angle of the condenser C .

COAL WINNING OPERATIONS AT YALLOURN, VICTORIA

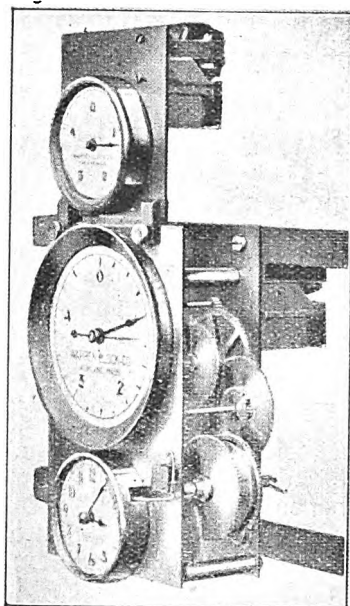
The February number of Chemical Engineering and Mining Review (Tait Publishing Co.) contains the first part of a very complete description of the coal winning operations of the state electricity commission at Yallourn, Victoria. The extensive brown coal deposit is being worked in an open cut by mechanical quarrying appliances. The overburden, which is about 30 ft. thick, is excavated by Bucyrus steam shovels and removed by a belt conveyor system. The coal is dug out by a Ruston electric shovel working on a 75-ft. bench and discharging into a travelling loader which loads the coal into the trucks of an automatic rope haulage system. The rope haulage conveys the coal out of the open cut to a screening house where it is graded. Two further rope haulages take the graded coal to the power house and briquetting factory respectively. All these various operations are described and a considerable amount of information is given regarding the mechanical details of the equipment used. Numerous illustrations accompanying the article assist in giving an adequate picture of the operations.

The Victorian electricity commission has established a wholesale depot for brown coal briquettes at Moreland in the Melbourne suburban area. Provision has been made for storing about 10,000 tons of the fuel and the object of the depot is to build up stocks during the summer so that the heavy demands during the winter months can be supplied at short notice.

8. Electric Journal, Feb., 1925.

The Warren Clock for Frequency Control

With the increasing tendency to interconnection of large power supply systems the question of the maintenance of constant frequency is becoming very important. Power station operators have been somewhat handicapped in this matter in the past, for their control of the frequency of supply has been limited by the shortcomings of the instruments available for measurement of frequency. Meters of various types have been in use for many years but they all suffer more or less from two great disadvantages. In the first place they have not sufficient accuracy. There may be errors of calibration and there certainly are errors arising from the effects of use and from temperature changes. These are great enough to allow of



Dials of Warren Master Clock

considerable variations in the actual frequency which, in a large interconnected system, may give rise to a good deal of inconvenience. In the second place these meters invariably measure the instantaneous value of the frequency. Now on all ordinary systems the frequency is continually varying over a small range owing to changes of load, consequently an instantaneous measurement, however accurate, does not necessarily give an average value. Accurate frequency control under such conditions is practically impossible.

An instrument has been developed recently, however, which gives at all times an accurate indication of the frequency of the supply system to which it is connected. It is known as the

Warren master clock. One of these interesting pieces of apparatus is installed at the Yallourn power station of the Victorian electricity commission. It consists of an extremely accurate spring-driven pendulum clock working in conjunction with a revolving hand driven from the a.c. supply by a small synchronous motor. There are three dials, as shown in the illustration. The lowest is an ordinary 12-hour clock dial for time keeping. The middle dial is calibrated into five minutes and has two hands: a black one driven by the clock mechanism and a gold one driven by the synchronous motor through suitable gearing. The top dial is an auxiliary to the main clock. It is divided into five minutes and has a single hand driven by an independent motor which is a duplicate of the regular motor. It is used as an emergency in conjunction with the clock hand of the middle dial in the event of the regular motor breaking down.

The operation of the apparatus is as follows:—

The gearing of the motor-driven hand is so designed that when the frequency is exactly correct the hand will make one revolution of the dial in five minutes, i.e., it will travel at exactly the same rate as the clock-driven hand. The hands are set so that, under normal operation, they travel exactly together. If the frequency varies from normal the gold hand tends to lead or lag from the black hand. This gives an indication of the average increase or decrease of frequency, and the variation is readily corrected for by control of the turbine speed. Under normal conditions the flywheel effect of the turbines, generators, motors, and all other machinery connected to a large system is so great, and the speed regulating characteristics of the governors are so accurate, that after equilibrium has once been obtained, the two hands of the clock keep close together for considerable periods without attention. The frequency may fluctuate both sides of normal, owing to sudden load changes, without perceptibly affecting the relation of the hands. Only errors in the average value, which is the important feature, will affect the hands materially.

The clock mechanism is regulated by a compensated pendulum and will keep time with an error of less than one second per day. Since there are 86,400 seconds in a day, the value of the average frequency may be measured over a 24-hour period with an error of within 1/500 of one per cent. This is a precision utterly beyond the reach of any ordinary frequency meter.

Electrical Equipment of the Yallourn Power Station—II.

All the 11 kv. connections, the 400-volt connections and the control wiring run underground from the turbine room and control building to the apparatus in the switchyard. The power cables are three core, lead covered, varnished cambric insulated. Where the current is such as to warrant it two or more cables are operated in parallel. The leads from each main generator to the busbars consist of two three-core 500,000 c.m. cables, and the leads from the busbars to the primaries of each main transformer bank

The control cables are multicore, lead covered, and are also carried in conduits. Some of the cables have up to 12 cores. Such of the control wiring as is supported on the switchyard structures is carried out with braided v.i.r. cable. The individual wires are brought out on terminal boards at both ends: the boards at the circuit breaker end are located in the housings of the operating solenoids, and those at the control end are mounted behind the switch panels in the control room.

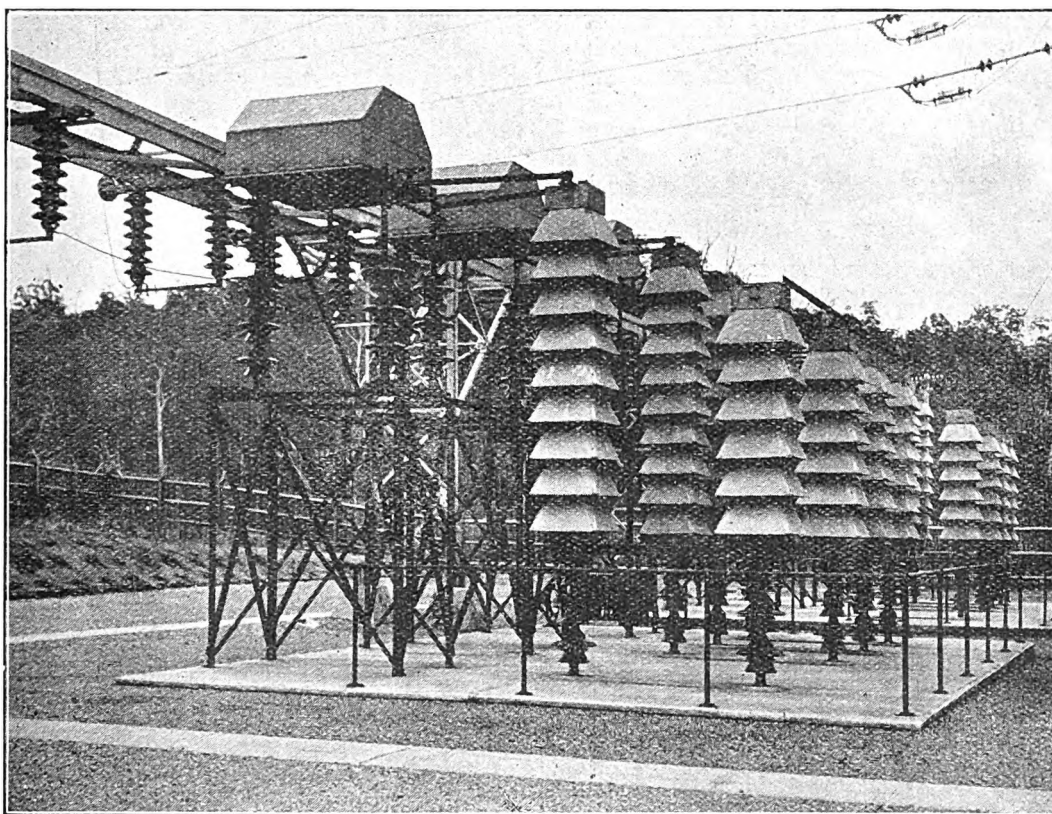


Fig. 7. 132 kv. Lightning Arresters.

consist of four similar cables. Each cable terminates in a compound-filled trifurcating box, where the parallel connections are made. The cables are run each in a separate conduit of fibre or galvanised iron, the former being used on straight runs and the latter where sets are necessary. The conduits are grouped into duct lines running between manholes. The manholes are concrete lined and are placed at positions where the duct lines change direction. The fibre conduit lines are set solid in concrete but the galvanised iron conduits are merely tamped in with earth.

Protection of the plant and equipment from the effects of lightning discharge is obtained by means of lightning arresters installed on each outgoing line. These are all of the oxide film type, operating in conjunction with spark gaps and choke coils. The arrangement of oxide film cells is such that the number from line to line is the same as the number from line to ground. The arrester is therefore divided into four equal legs meeting at a common point and connected respectively to each of the three lines and to ground. The arresters on the 132 kv. lines have 292 cells per leg and operate in

conjunction with hemisphere gaps set $3 \frac{1}{16}$ in. apart. Those on the 22 kv. lines have 48 cells per leg, and those on the 6.6 kv. lines have 14 per leg. The spark gap settings are considerably smaller for the lower voltages, and on the 6.6 kv. lines horn gaps are used instead of hemispheres. Fig. 7 shows the 132-kv. arresters.

In addition to the lightning arresters a high frequency absorber has been installed. This device allows high frequency disturbances in any of the lines or equipment to pass harmlessly to ground. It consists of a number of resistances and condensers connected in series between the 11 kv. transfer bus and earth. The connection to the bus is made through expulsion fuses. The absorber is made up in four legs in a manner somewhat similar to the lightning arresters, the arrangement being such that there is equal condenser capacity between phases and between each phase and earth. The condensers provide a ready path for the discharge of high frequency potentials but present a lower admittance to line frequency potentials. Under normal conditions, therefore, only a small charging current flows. The condensers and resistances are installed in an iron tank filled with oil.

Special precautions have been taken to provide good earthing for all apparatus. An earth bus, consisting of a 500,000 c.m. stranded copper cable, runs round the switchyard and through the turbine room and boiler house. This is connected to nine copper earth plates located in various parts of the yard. The plates are 3 ft. square and are buried in sand and coke at a depth of about 6 ft. A vertical pipe is set over each for watering purposes. As an additional precaution, to make sure of good earthing under all conditions, two additional earth plates have been buried on the bank of the Latrobe river some 140 ft. distant. They have been placed below river level about 25 yd. apart in permanently moist ground, and they are connected to the main earth bus by separate 500,000 c.m. copper cables.

To this earthing system are connected the steel structures, the circuit breaker tanks, the frames of the generators and all the neutral and earthing points of the various units of the plant. The star points of all the transformer banks are solidly connected to the earth, and the neutrals of the generators are arranged for earthing through circuit breakers. In order to eliminate third harmonic currents, however, only one generator neutral is earthed at a time. The lightning arresters also are connected to this earthing system, and in order to give as short a path to ground as possible, one of the earth plates is buried close to each lightning arrester.

Relay Protection

Several types of protective gear are in use for safeguarding the various pieces of apparatus

against overload and short circuit. Differential protection is used for the main generators, house generator and all transformer banks. Inverse time limit relays are installed on each outgoing line, and where two lines are operated in parallel (as in the case of the main 132 kv. line, and the feeders to the briquetting factory) balanced relays are used as well.

The switchgear of each main generator is so interlocked that if the protective apparatus causes the main circuit breaker to open, the field switch and neutral circuit breaker open immediately after it. This is arranged for by wiring the tripping circuits of the last named switches through auxiliary switches which are automatically closed by the main breaker as it opens. The tripping current of the main breaker energises a bell relay, causing an alarm bell in the control room to give warning to the operator that the switch has tripped. The operating relays and bell relay have to be reset by hand after an operation.

For the protection of the main transformers time limit overload relays are used in conjunction with differential relay transformers and two auxiliary relays. The closing of the contacts of the overload relay energises the auxiliary relays which in turn trip the circuit breakers on both the primary and secondary sides of the bank. On the feeder and house transformer banks protection is given by differentially connected overload relays equipped with three contacts, which give two tripping circuits. In these cases auxiliary relays are not required for tripping the h.t. and l.t. circuit breakers. For the auxiliary transformer banks three auxiliary relays are used in conjunction with the differentially connected instantaneous relays. Two of these open the h.t. and l.t. circuit breakers respectively, while the third closes another circuit breaker to connect the load which the transformer bank was supplying to the 400-volt emergency auxiliary bus. This provision ensures continuity of operation of the auxiliaries.

Current transformers of several types are used for operating the various relays. Those on the 132 kv. circuits are of the bushing type and are accommodated in the circuit breaker housings. Their ratio is 60 to 1. Most of the current transformers step down to 5 amps. In all cases metering is done from separate transformers to those used for relay operation. Potential transformers are used for operations connected with metering and synchronising and for the operation of the Tirrill regulators and the frequency indicating apparatus. They all step down to a secondary pressure of 110 volts. There are 24 operating on the 11 kv. circuits, two on 22 kv. and four on 6.6 kv. None are used on the 132 kv. circuits and there is only one on 400 volts, this being used in connection with synchronising the house generator. The

400-volt metering is carried out at 230 volts, the neutral being available for the purpose.

Control Equipment

The control building is a two-storied brick structure with the control room situated on the upper floor overlooking the switch yard. The room accommodates a bench board for controlling all main equipment, a meter board, Tirrill regulator board, relay board, control board for 400-volt distribution circuit breakers, transformer temperature indicating board and generator temperature indicating board. There is also a telephone switchboard and certain subsidiary equipment. The 400-volt distribution board for station and local supply is situated on the ground floor of the building, as also are the 250-volt storage battery for control operation, the motor-generator battery-charging set, and the spare and charging exciter sets.

cording instruments comprising voltmeters, ammeters, frequency meters, wattmeters and a totalising wattmeter. The last-named instrument records the total output of the station; it has 10 circuits, corresponding to the 10 generating sets ultimately to be installed.

The Tirrill regulator board is situated to the right of, and in line with the bench board. It mounts the five Tirrill regulators used in conjunction with the present generating sets. Provision has been made for the installation of a similar board to the left of the bench board when the station is extended.

All the protective relays are mounted on the relay board situated at the back of the control room. This board also has a mimic bus with white lights showing the position of the circuit breakers which the relays trip. Each light glows when its breaker is closed, but re-

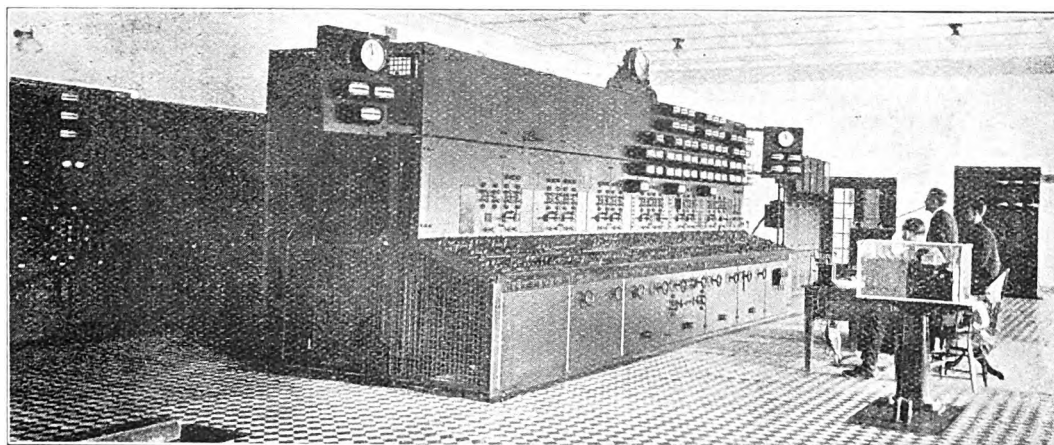


Fig. 8. Control Room

The bench and meter boards are mounted back to back in the centre of the control room. The bench board accommodates the control switches for operating the circuit breakers, switches for the excitation and turbine governor control, synchronising plugs, signalling apparatus, etc. The 132 kv. motor-operated isolating switches are also controlled from this board. On the upper part of the board are the various indicating wattmeters, ammeters and voltmeters. Synchronism indicators and synchronising voltmeters are mounted on swinging brackets, one set at each end of the board. On the bench portion a mimic busbar arrangement is set out, forming a single line diagram of the main connections of the station. The various pull switches, with their indicating lamps, are located at the appropriate positions on this mimic bus.

The meter board accommodates integrating watt-hour meters for measuring the energy generated and distributed. It also mounts re-

mains dark when it is open. In connection with this board there is a testing panel for checking up the condition of the different relays and their associated current transformers. It provides control for a 10 kv.a., 400/110 volt testing transformer and an induction regulator.

The 400-volt station service and battery control board consists of four panels mounting switches for controlling the air circuit breakers on the 400-volt distribution board situated on the ground floor.

The temperature indicator boards are placed one at each end of the control room, and run at right angles to the other boards. The generator temperature board mounts millivoltmeters calibrated in degrees Centigrade, which communicate with thermocouples embedded in the stator windings. There are six thermocouples per machine, and they may be connected in turn to the millivoltmeter through a transfer switch. The transformer temperature board

accommodates meters calibrated in degrees Centigrade, which measure the resistances of coils embedded in the transformer windings. Here again transfer switches are used for making connection with different coils.

In addition to the equipment already mentioned, the control room houses two interesting and valuable pieces of apparatus. One is the Warren master clock, for accurate frequency measurement. This device and its principle of action are described elsewhere in this journal. The other piece of apparatus is the multi recorder, a device for recording on a chart the exact time of occurrence of every switching operation. This particular recorder is a 50 point machine, i.e., it is able to record the operation of 50 different switches. Each circuit breaker is connected to it through two relays, one or other of which is closed according as the circuit breaker closes or opens. The recorder has two distinct mechanisms—one for timing and one for printing. The timing mechanism is driven by a small shunt wound motor running at exactly 1,800 r.p.m. The motor speed is controlled from a master clock through a device which automatically cuts resistance into or out of the motor field as the speed tends to rise or fall. There are two sets of type wheels for printing: one, actuated by the relays, bearing a number and a dash corresponding to each circuit breaker, and the other, driven by the timing mechanism, carrying the day of the week and the hour, minute and second. The chart on which the recorder prints is moved forward only when some switching operation takes place. When a circuit breaker is opened or closed its relay operates a magnet to bring the type wheel into position, and also operates a row of hammers under the type to print a line of characters across the paper, showing the position of every circuit breaker at the time. If a breaker is closed its number appears on the chart; if it is open a dash is printed. At the instant of operation two time figures are printed from the time wheels, giving the time in seconds and (by means of an arrow) quarter seconds. Energy from a 24-volt storage battery is used to operate the recorder mechanism.

Telephone Communication

Direct telephonic communication between the control room and the Melbourne end of the transmission line (the Yarraville terminal station) is provided by two telephone lines carried on wooden poles which follow the route of the transmission line. The lines terminate at Yallourn on a telephone switchboard located beside the operator's desk in the control room. From this board lines radiate to various parts of the control building and the power station. In addition a number of trunk lines run to another switchboard in

the administrative building, from which further lines radiate to all parts of the works. The battery and other apparatus for the telephone system are located in the control building, in the room containing the motor-generator sets. There is a small motor-generator and switchboard for charging the battery, and also a bell-ringing motor-generator.

Lighting

An efficient system of lighting has been installed for illuminating the switchyard at night. General illumination is given by 100-watt lamps carried in fittings mounted on the handrails of the walkways on the steel structures. In addition plug sockets are provided for floodlights for use when carrying out repair work at night. In the power station building the main lighting is by 750-watt lamps carried on the roof trusses. In addition there are bracket lamps for local lighting and sockets for portable lamps. All the lighting circuits are supplied from the station service board in the control building. An automatic double throw switch is mounted on this board, which, in the event of failure of the whole a.c. supply, will throw a few lights in each part of the buildings on to the storage battery.

ELECTRIC STREET SIGNS

The Melbourne city council has drawn up an amended set of regulations governing the erection of electrically illuminated signs in the streets. These are designed with a view to ensuring the safety of the public and to prevent the erection of unsightly advertisements in the city. The size and form of lamps attached to buildings are under strict control. Globes must not exceed 12 in. diameter and must be plain, except that special fittings harmonising with the appearance of the building will be permitted, subject to approval. Lamps under cantilever verandahs must not be more than 12 in. deep and 18 in. wide. The only writing permitted on a globe will be a single line on each side, stating either the name or the calling of the occupier of the building. Colored globes are only permitted for chemists, dentists and doctors. Opal box signs of approved dimensions will be permitted on the ends of verandahs or attached to buildings, but these signs must not be intermittent in operation, although changing of colors will be allowed. Large signs constructed of galvanised iron troughing may be erected in approved positions on buildings and these may be intermittent if located more than 20 ft. above the street pavement. The regulations lay down strict provisions regarding the location of signs and the distance the sign structure may project from the building.

Electric Supply for North-Eastern Victoria

Large Transmission Spans

The first section of the Victorian electricity commission's north-eastern district electric supply system has been put into operation. Energy has been made available to the town of Corowa, and in a few weeks supply will be given to Albury. Both these towns are on the New South Wales side of the River Murray.

portion of the supply comes from Yallourn. The transmission lines from Yallourn to Albury constitute the longest lead of electrical energy in Australia. The total distance covered is 303 miles, made up of 110 miles of 132,000-volt line from Yallourn to the Yarraville terminal station at Melbourne, 14 miles of 22,000-volt

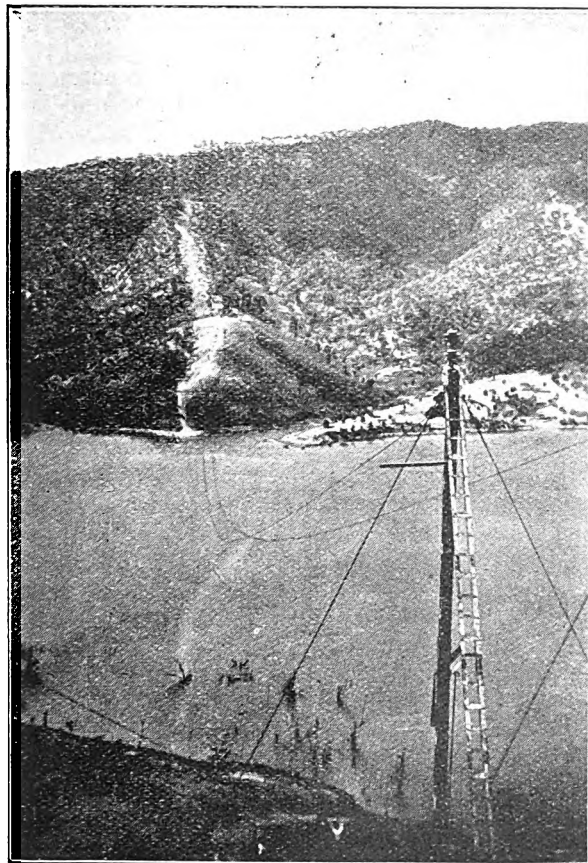


Fig. 1. Span Across Sugarloaf Dam at Eildon, Showing Two Conductors in Position.

In the course of a few months the supply will be extended to several towns throughout the north-eastern part of Victoria.

At present the energy is derived from the primary distribution system which serves the city of Melbourne, by means of a 66,000-volt transmission line which ties in at Thomastown, a few miles to the north of the metropolis. The 66,000-volt line terminates at Wangaratta, and 22,000-volt lines cover the remainder of the distance to Corowa and Albury respectively. The energy is generated in the electricity commission's coal burning power stations at Yallourn and Newport. The latter station is maintained as a peak load supply, so that the greater

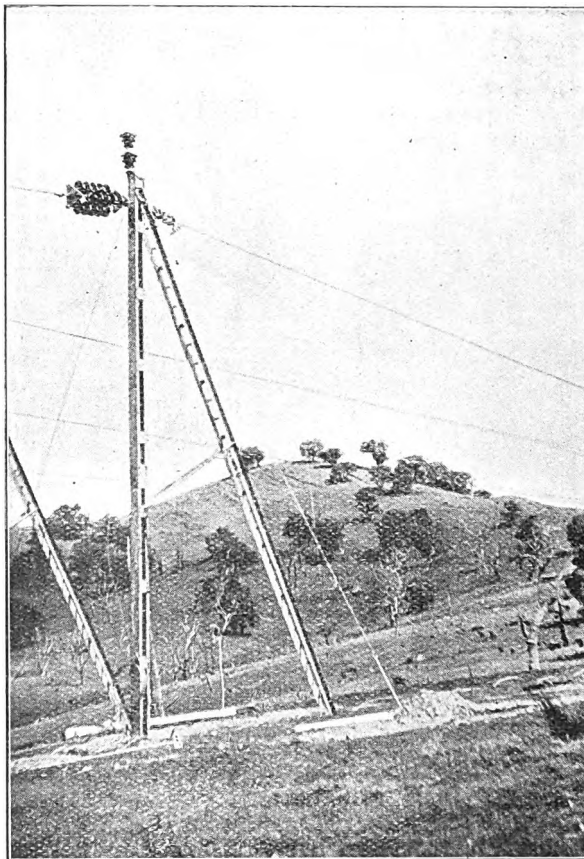


Fig. 2. Terminal Structure for Long Span Across Delatite Arm

underground cable and overhead line from Yarraville to Thomastown, 134 miles of 66,000-volt line from Thomastown to Wangaratta, and 45 miles of 22,000-volt line from Wangaratta to Albury.

The 66,000-volt line has some interesting features. The conductors are of 0.159 sq. in. aluminium, steel reinforced. On straight portions of the line they are suspended from wooden H frame towers, 800 ft. apart, but at angles and tension points special steel towers are used. Provision made on the supports for two circuits, but at present only one is erected. A considerable portion of the line runs through rough hilly country, and there are some very

large spans. The two largest are where the circuit crosses the Sugarloaf reservoir: one is just above the dam at Eildon and has a length of 4,726 ft.; the other is at the crossing of the Delatite arm and is 3,840 ft. long. Fig. 1 shows the Eildon crossing with two conductors in position.

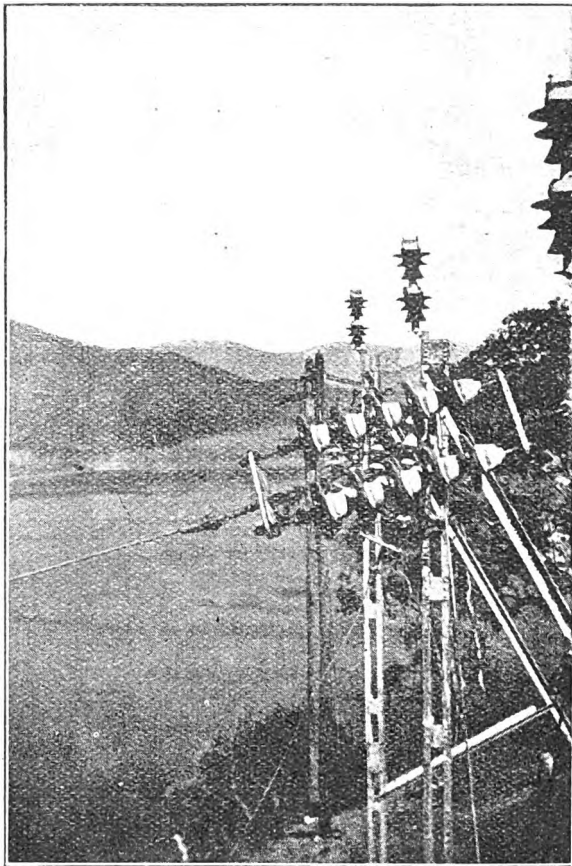


Fig. 3
Fig. 3. Structures and Strain Insulators at Sugarloaf Crossing

At these spans steel conductors of 37/14 gauge, with breaking strength of 200,000 lb., are used. There are four conductors at each crossing, one being retained as a spare. The supports are of a very simple nature, for the height of the hills rising from the water's edge obviates the necessity for high terminal towers. An idea of the height at the Eildon crossing can be obtained from Fig. 1. The distance from the structure to the cable barge near the bank is about 1,200 ft. and the vertical height is about 450 ft. A separate structure is provided for each conductor, consisting of a steel pole 35 ft. high, built up of two 9 in. x 3 in. x 17.46 lb. channels with a tension brace of two 5 in. x 5 in. x 5/16 in. angles. The pole and brace are bolted to concrete foundations and are guyed at the sides by steel ropes. Fig. 2 shows one of the structures at the Delatite crossing. These supports are spaced at 20-ft. centres.

The conductors are attached near the tops, through tension insulators which consist in each case of three strings of four units arranged in parallel. One of these insulators is clearly seen in Fig. 3. At the Eildon crossing the tension on the conductors is 7,118 lb. and the sag is 270 ft. at 60 deg. F.

The illustrations of the structures show two pin type insulators in series attached to the top of each pole. These are to carry a transfer bus, by means of which the connections between the lines on the land side of the structures and the span conductors may be changed over. This allows of any one of the span wires being thrown out of circuit if necessary. At the time the photos were taken the bridging connections around the structures, and the buses and isolating switches had not been erected.

SUGARLOAF-RUBICON HYDROELECTRIC SCHEME

The Victorian electricity commission is calling tenders, returnable on March 1, for the construction of portion of the hydraulic works in connection with the Sugarloaf-Rubicon hydroelectric scheme. The works include dams, race lines, forebays, pipe line foundations, etc., serving the Rubicon, Rubicon Falls, Royston and Lower Rubicon mountain stream hydroelectric stations, and also portions of the power station buildings. Three offtake dams are to be constructed: one of concrete arch form, 35 ft. high and 140 ft. long on the crest, on the Rubicon river; one of reinforced concrete slab form, on the Royston river; and one of the latter form at Rubicon Falls. Five offtake weirs also are to be built: two, of timber crib construction, on Lubra creek; and one of similar construction on Beech creek; and one each of mass concrete construction on Rubicon river and Royston river. Race lines and flumes are to be laid down from Rubicon offtake to Royston power station, Royston offtake to Royston pipe head, Royston power station to Rubicon pipe head, and Rubicon power station to Lower Rubicon pipe head, and feeder pipes are to be laid to tap Beech and Lubra creeks. The contract also is to include the pipe line foundations at the Royston, Rubicon and Lower Rubicon power stations.

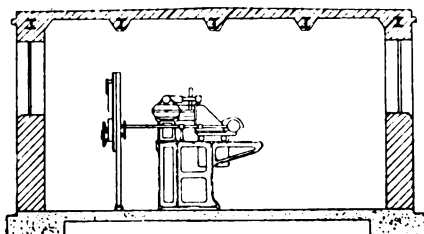
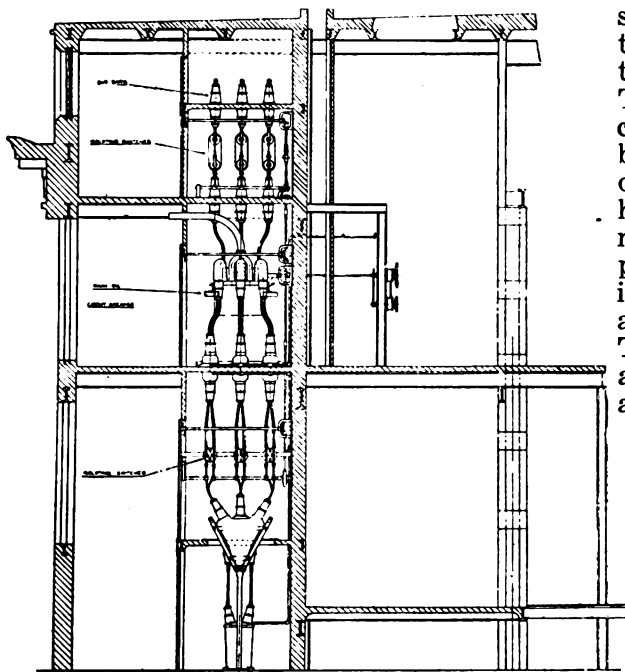
The country in which this work is to be carried out is extremely rough and difficult and the greater portion is covered with heavy forest growth. The question of transport constitutes a serious problem which has given the officers of the commission a great deal of thought. The difficulties, however, will be overcome by the extensive utilisation of narrow gauge tramways and rope haulages.

Metalclad versus Outdoor Switchgear

The design of switchgear in Great Britain has developed along widely different lines from that in America. In the former country indoor installation of apparatus is favored, while in the latter outdoor equipment is now almost universal. The desideratum, of course, is the production of equipment which will give best service at least cost, and it is interesting to note the widely divergent practices which have been followed in the endeavor to reduce costs. For many years the cell type of indoor construction held sway, and indeed in many

lost in the necessity for so much interlocking of apparatus.

The American departure from the cell type gear, along the line of outdoor construction, eliminates most of the expense of housing, as the control may be centred in a quite small building. This is counterbalanced to some extent, of course, by the increased cost of the weatherproof switches, transformers, etc. But British engineers have not followed this lead. They concede that properly designed transformers may with advantage be placed out of doors, but their experience favors housing for switchgear. The British manufacturers' answer to the demand for greater economy has been the production of the metalclad type of gear. This type is of unit construction, with all h.t. conductors and insulators completely surrounded by metal enclosure and either immersed in oil or run in solid with compound. Many forms have been devised, but common to all are two main components or sets of parts—the fixed part and the removable part. The fixed part includes the cable entry and busbar connections and sometimes the instrument transformers. The removable part carries the circuit breaker and mechanism which operates it. All removable portions are made to jigs and gauges so as



Comparison to Same Scale of Dimensions of Cell and Metalclad Gear Respectively for 20,000 volts.

quarters it is still looked upon as standard practice for high tension work in connection with large generating stations. In this system the conductors and apparatus are thoroughly protected by doors and partitions, the supporting framework being built of brickwork or ferro-concrete. Large clearances are employed, the gear being divided amongst compartments on several floors. Interlocking of the doors is used to prevent accidental contact with live metal, and interlocking of equipment to ensure proper sequence of operation. This type of switchgear, however, has the great disadvantage that large and expensive buildings are required to house the cells. It is notable also that the great advantage of cell construction, viz., visibility of the conductors and ease of access in emergency or for repairs or extensions, is being

to be interchangeable for all panels of the same current-carrying capacity. The busbars are metalclad and compound filled, each bus being separately contained within an earthed metal enclosure. This principle of the complete and separate enclosure of each phase is carried throughout the gear and applied to all high tension conductors, so that the starting and spreading of an arc between phases only is impossible.

The development of these two very different types of gear in Great Britain and America has possibly been influenced to a considerable extent by the difference in transmission practice in the two countries. In the former underground transmission is almost universal, and switchgear of the metalclad type is designed for connection to underground cables. In the latter overhead

transmission is the general practice and the use of outdoor switching seems only logical. Consideration of the two practices shows that each is very economical as compared with the cell type of gear, and that the indoor metalclad equipment will run very close to outdoor construction in economy. For small installations and for distribution station work the outdoor construction has the advantage, but for power station switchboards on any large scale there

appears a good deal in favor of the metalclad type of gear. In situations where the availability of ground space is a deciding factor there is no question about the advantage of the metalclad gear. The diagram* makes quite apparent the economy in building construction for metalclad as against cell type switchgear. The economy in ground space over outdoor switchgear will be self evident.

Electric Supply in Great Britain

Annual Report of the Electricity Commissioners

The fifth annual report of the British electricity commissioners contains much interesting statistical matter relative to the development of electricity supply in Great Britain. On March 31, 1925, the number of local authorities, companies and persons holding statutory powers for the supply of electricity was 568. The total energy generated during the year 1924-25 amounted to 7,415,375,500 kelvins. The fuel consumption was as follows:—Coal 7,892,400 tons, coke breeze 95,400 tons, oil 54,400 tons. Of the total energy generated 6,047 million kelvins were produced by authorised undertakers and 1,368 million kelvins by traction and non-statutory undertakings. The returns show an increase in energy generated of 11 per cent and in fuel consumed of 6 per cent. Of the 584 stations dealt with, 43.7 per cent generated less than 1,000,000 kelvins each, and 74.3 per cent generated less than 10,000,000 kelvins each. The policy of the commissioners has been to bring about the supersession of the small-scale generation in a multiplicity of stations, but during the past year they have found it necessary to sanction the establishment of several small plants in order to make supply available to rural districts.

During the year the energy sold by local authorities amounted to 3,167,387,600 kelvins, and that by companies to 1,830,575,700 kelvins. The total increase over the previous year was 15 per cent. On the basis of the 1921 census the energy sold represented an average consumption of 117 kelvins per annum per head of population. This figure does not take into account the supplies generated in stations operated for railway or tramway purposes or in plants owned by large industrial organisations.

The aggregate capacity of generating plant for new stations and for extensions to existing stations sanctioned during the year was approximately 480,000 kw. This does not represent a net addition to the generating capacity of the country, as in many cases the installation of new plant involved the displacement of old equipment. During the year 12 consents were

issued in respect to the establishment of new stations, involving plant with total rated capacity of 16,680 kw. Consents were given for extensions to 92 existing supply stations, and 11 further consents for extensions to stations owned by railway and tramway authorities and non-statutory undertakings. Consents have been issued in respect of 47 applications for the establishment of main transmission lines. A number of these related to 33,000-volt lines and two to 66,000-volt schemes.

Applications from local bodies for permission to borrow money for electric supply purposes received sanction in 562 cases. The total amount involved is £13,379,060. Permission has been given in 24 cases for alteration of voltage in supply systems. In most instances this involved changing from a non-standard frequency or from d.c. to 400/230 volts, 50 cycle three phase a.c.

A general reorganisation of electricity supply is being made throughout the country. Electricity districts are being proclaimed, and progress is being made towards unification of effort in these districts. Four of these schemes came into operation during the year. An important work was carried out in connection with the constitution of the London and Home Counties electricity district. The order came into force in July, 1925. The total capacity of generating plant installed or sanctioned in this district at March 31, 1925, amounted to 1,139,200 kw.

During the year the commissioners had occasion to give further consideration to the general question of methods of charge and multi-part tariffs, and its bearing as a factor in securing a more extensive development in the use of electricity for domestic purposes. After consultation with the principal associations representative of the electricity supply industry, the commissioners decided to appoint an advisory committee to consider and report upon the question of the establishment of a few model or standard methods of charge, for the guidance of electric supply authorities.

*From a paper by H. W. Clothier in the "World Power Souvenir of the British Empire Exhibition, 1924."

Supervisory Control Systems

During the last few years there have been some remarkable developments in methods of controlling the generation and distribution of electrical energy. Manual operation of hydro-electric stations and rotary substations has given place in many cases to automatic operation. The latest development is the substitution of supervisory control for complete automatic operation. A recent article in the "G.E. Review" briefly discusses the advantages of supervisory control and describes the essential features of some of the systems in present use.

Purely automatic operation has certain disadvantages. Although automatic equipment can be made thoroughly reliable and self protecting there are emergency conditions over which the station has no control. This might be illustrated by the case of a fire in a certain section of a city where the electrical circuits are supplied from an automatic substation. In this case it is necessary for the load dispatcher to open the feeder circuits supplying this district.

The use of telephony for the transmission of operating orders divides the responsibility and very often leads to costly errors. In cases of emergency, the telephone is also relatively slow for the transmission of orders. The supervisory system, however, provides a direct and speedy method by which the dispatcher can perform his own operations and he is automatically advised of any change in his system set-up.

A supervisory system besides making a saving in operating expense, provides a means whereby a power system can be operated as a unit. Unit operation of installed power equipment assures the maximum operating efficiency.

There are four principal supervisory systems at present in use, viz., the distributor system, the cable system, the selector system and the carrier-current selector system. The distributor system is applicable to the supervision of stations which contain a large number of power units located at a considerable distance from the dispatcher's office. Four line wires are required between stations for controlling up to 50 pieces of equipment. The operating part of the system consists of two motor driven distributors, one in the dispatcher's office and one at the station being operated. The distributors are equipped with rotating brush carriages which are driven in synchronism by fractional horse power d.c. motors. A complete revolution of the brush carriage is made in five seconds. The brushes travel over a series of contact studs. For the control of each piece of apparatus at the station there is a key on a switchboard at the load dispatcher's office. Each key communicates with a stud on the dispatcher's distributor, and at

the station end each piece of apparatus is operated by a relay connected to the corresponding stud on the station distributor. As the brushes of the two distributors rotate continuously in synchronism they serve to make momentary contact once every five seconds from each control key to its corresponding relay, thus providing a path for operation. The operating current is supplied by storage batteries. The control switchboard is equipped with lamps which give a visible indication of the position and operation of each switch at the station. The maximum period that can elapse between the actuation of a control key and the operation of the corresponding relay is five seconds, i.e., the time of one revolution of the distributors. In addition to the control keys there is a master key which prevents a false operation due to the accidental turning of one of the control keys. No control operation can be performed unless the master key also is turned. Any number of control keys can be turned at one time and all operations will be completed within a maximum time of five seconds after turning the master key. Indication of the new positions of the supervised apparatus is registered on the indicating lamps within a further five seconds. In the case of any of the automatic equipment of the station operating, such as a circuit breaker tripping, the supervisory system advises the load dispatcher by a lamp indication.

The cable supervisory system finds its application where the distance between stations is short. A multiple conductor lead covered cable is run between the stations instead of using distributors, thus the control keys operate the relays direct.

The selector supervisory system is designed for the supervision of a few units only in each of a number of outlying stations. It will operate over three wires running continuously from the dispatcher's office through all the stations. The control is by means of keys which operate code sending devices. For each code sent from these keys there is but one selector in the system that will close a contact. Two keys are used for each circuit breaker, one to close and one to open. In this system only one key can be operated at a time. It takes about seven seconds to carry out an operation, and about the same time to receive the return indication. The coded signals and relays are operated by means of small storage batteries.

The carrier-current selector supervisory system may be applied where the installation of three line wires between stations is undesirable. In this system supervision may be accomplished

over a single circuit, an existing open wire telephone circuit, or even over the transmission line itself. The same equipment is used as is employed in the selector system, the difference being in the carrier-current system of transmitting the coded signals. With the carrier current the speed of operation is considerably increased over that of the plain selector system.

It is interesting to note that supervisory control is specified for some of the hydroelectric stations of the Victorian electricity commission's Sugarloaf-Rubicon scheme, for which tenders have been called. Undoubtedly considerable economies in operation will be effected by such control. The city council of Wellington, N.Z., also is investing in a supervisory control system in connection with the distribution of energy

for the tramways. Three new 750-kw. rotary converter substations, at Newtown, Thorndon and Karori respectively, are being equipped for supervisory control. The Newtown station is already in operation and the plant for the other stations is now being supplied by the Metropolitan-Vickers Electrical Co. Ltd., England. The selector system has been adopted, and the selector gear is similar to that used for automatic telephony. It was supplied by the Automatic Telephone Manufacturing Co., of Liverpool. Selective keys are provided on the control desk for starting and shutting down the rotary converter, for closing and opening the main d.c. contactor and high speed circuit breaker, and for closing and opening any of the d.c. traction feeders. The actual running up to speed of the rotary is performed automatically.

The Future of Domestic Electrification

A Canadian Opinion

Mr. T. L. Moffat, of Moffat's Ltd., electric stove manufacturers, Weston, Canada, who passed through Sydney and Melbourne recently, has great faith in the future of domestic electrification. He considers that every effort should be made to encourage the domestic load, particularly in regard to cooking and continuous water heating. There is no doubt about the advantages of electric service to the consumer, and experience has proved that the domestic demand is a very desirable load for the supply undertaker. Referring particularly to electric cooking Mr. Moffat says that, premising thorough reliability of the equipment and power service, the essentials for comprehensive exploitation of the domestic field are low costs. The prospective consumer may be perfectly convinced of the conveniences incident to domestic electrification, but unless the price is right, i.e., within reasonable reach, no sale can be effected. Electric service must be made available in the widest possible manner. To effect this every effort must be made to reduce to the minimum the first cost of equipment, the installation expenses and the energy tariffs. These are the three fundamentals. In Canada electric ranges of the two most popular sizes may be purchased for £25 and £16 respectively; the cost of installation averages about £9; and the usual price of energy for domestic service in the larger towns is $\frac{1}{4}$ d. per unit. One meter tariff systems are the general rule, and the use of electrical energy in the home is encouraged to such an extent that, even at the very low tariff rate, the weekly electricity bill of an all-electric home may be about 13/-.

Mr. Moffat emphasises the liking of the electric supply authorities for the domestic load, which is universally recognised as both good and profitable, but he points out that the radiator load must not be included in this. He does not favor electric radiators for house heating, looking upon the dissipation of electrical energy as broadcast heat to be purely wasteful. He sympathises with the opposition of electric supply authorities to the use of radiators, as the load is liable to cause heavy peaks.

As regards his own firm, Mr. Moffat points out that it has been established for 35 years, graduating from the manufacture of wood and coal stoves to gas, and finally into the electric field. Its products, therefore, have the backing of extensive experience. A great deal of trouble has been expended in perfecting the design of the Moffat ranges. Materials and manufacturing processes have been subjected to many alterations in the endeavor to find those that will give the best complete article at least expense. A considerable amount of research has been devoted to the design of the heating elements. Closed, protected and open type elements have been tried out, and the weight of opinion favors the open type on all counts—efficiency, safety and reliability. The resistance wire now used is a nickel-chromium alloy made in Canada, which has long life due to its excellent anti-corrosion properties. A tribute to the quality and reliability of the Moffat stove lies in the fact that there are now over 65,000 Moffats in use in Canada alone, and that over 50 per cent of the ranges sold in the Dominion during the last five or six years have been Moffats.

Salesmanship

In a paper read before the Electrical Trades Commercial Travellers' Association, in England, Mr. V. W. Dale recently touched on several points essential to the successful conduct of sales transactions by the representatives of wholesale electrical houses. Amongst the personal qualifications necessary in a salesman are: enthusiasm, optimism, courtesy, cheerfulness, sincerity, honesty, self-confidence and good health. But even when all these are present there are many points which the salesman must give careful heed to if he is to do good work.

One very important matter is to see to it that there is no time wasted in the day's work. Actual order getting and money making hours are all too short; it is vital to personal interest as well as the interest of the firm that every available moment should be spent profitably. Time can be saved in many ways. For instance, a careful mapping out of the day's round can usually be made, so that the maximum number of prospective customers can be called upon with a minimum of travelling. When, due to unforeseen delays, carefully planned arrangements do break down, reference to a telephone book or classified directory will usually help by showing how time can be occupied by a call on some new potential customer.

In addition to saving his own time the salesman must be considerate of the time of his customers. The retailer has other interests in life besides buying goods and the salesman should not take more time than is absolutely necessary for a thorough but brief exposition, and demonstration if necessary, of the merits of his goods.

Another time saver can be secured by definitely avoiding entirely fruitless calls. The fact that the man the salesman wishes to see is not in is rarely if ever a sufficient reason for leaving a place without seeing anybody. Generally the proprietor or the buyer has an assistant—and it is always well to give due respect to the assistants.

Another point is that all salesmen should give some attention to the important influence of suggestion in selling. The great body of the spending public, as a rule, buys only just what it actually knows or feels that it wants. For every known want there are probably two unknown wants. The need has to be revealed. This is the basis of all knowledge and educational work. It is for every salesman to take up the task of actually revealing those wants directly to the public, or to the retailer who serves the public. For instance, even in considering anything as commonplace as lighting,

not only members of the public, but sometimes the retailers, are woefully ignorant concerning the proper and possible expansion of its uses. Such ignorance obviously retards development and reduces the number and size of orders. Most people are more or less conscious of their need of artificial illumination but generally obtain it without a single thought on their part; some builder has provided a centre pendant or a gas bracket and when darkness falls the switch or match is applied and they get all the light they think (or don't think) they need. Now these same people want convenience points over the bed, the dressing table, in the wardrobe, reading lights, night lights, etc., a light over the sink, a light above the cellar steps, in the pantry, the porch—they want better switch controls—but they don't know that they want them—the knowledge of need has to be aroused. Unless suggestion is brought in—by advertising and by salesmanship—thoughtless people will endure needless inconvenience until the last trump sounds.

Another jumping-off point is to reason out why entirely dissimilar people buy precisely the same articles. It must be remembered that when people buy lamps, heaters, cookers, power appliances, and also electrical energy for their use, they are not making merely prosaic purchases, they are actually buying comfort, convenience, service, saving of work, better health, they are buying something better than their neighbors and friends possess. They can be appealed to from so many different angles. All these impulses and emotions are well worth studying and analysing by salesmen. Countless avenues for exploitation and fresh markets would open out as a result.

Amongst other points is the necessity for tolerance of the opinion of customers when they have doubts of the value of, or the possible market for, the goods offered. Talk alone cannot be expected to immediately convince a man to whom a proposition is introduced for the first time. It will often be necessary to make the case good by patient demonstration. A very important point is that a salesman must always keep his temper—it is too valuable to lose. But at the same time there is no necessity to always meekly take the snubs of bullying buyers. A proper retort in the right place will often earn respect where a soft answer would fail.

Another aspect that must be studied is the necessity that sometimes arises of convincing customers against preconceived but utterly unfounded prejudices that there is actually a local need or a latent demand for a particular line;

that the public will buy as it is buying in other districts if only the selling is right. The obstacles must be met by the salesman letting the customer see that he is absolutely reasonable and sincere. But on no account must a customer be oversold. Experience will show also that different grades of goods sell best in different parts of the country, and that the selling factors are not always in consistent relationship with the class or grade of society.

It is strongly recommended that salesmen keep themselves absolutely up-to-date on their firms' advertising and publicity. The executive and management should be induced to adopt the practice of giving the salesmen advance copies of all daily press and magazine advertisements, also of all publications and catalogues. The salesman is the ambassador of his firm, and it is an absurd position for the customer to be better informed of a firm's publicity than its own representative. In addition all electrical salesmen should read at least one or two trade papers regularly.

In the relation between salesman and customer the salesman should remember that he is something more than a man who just sells goods. He is there to render a service to his customers. One way in which this can be done is by keeping his eyes open and noting where the customer's business methods might be improved. For instance it is often possible to convey valuable tips and suggestions to customers for improving the attractiveness of windows and showcases, utilising the space in their show-rooms to greater advantage, organising better displays and arranging periodic demonstrations, etc. Maybe a customer is not making the most of supply network extensions! Is he circularising the area and following up with a canvass? Is he overlooking in his estimates provision for the use of small heaters and other domestic appliances? Help can be given by suggesting and drafting suitable follow up letters calling customers' attention to the remarkable convenience and labor-saving qualities of many small electrical appliances which, as lighting consumers, they could very well use. Again if the best use is not being made of windows for demonstrating modern shop window lighting, a word in season will probably be mutually helpful. A tactful salesman will find many ways and means of imparting valuable information without causing the customer the least resentment and without making him feel that he does not know how to run his own business. Of course, it needs tact, but if a man simply cannot be tactful he should not be a salesman. When scope for boosting sales is so glaring that the absence of intelligent effort is obvious, an endeavor should first of all be made to discover the customer's point of view, his "reasons why." Then the suggestion of some sound and practical scheme

which has worked well elsewhere, may be put forward. But no attempt must be made to dominate the customer; that would be fatal. It is always unwise to make a man feel conscious of the fact (however true it may be) that he is really doing himself a good turn by adopting the other fellow's proposition.

Salesmen are generally good talkers, but in this connection care must be taken not to overdo the matter. Many orders are lost on account of a too agile mind and tongue. It is very important to try and estimate the listener's capacity for intelligent reception, and to adapt oneself to circumstances. Unfortunately many people will continue to listen without interruption or comment though they do not in the least understand what it is all about. Arguments must be presented in a logical and convincing manner, and in good English.

Of course a most important matter is that personal efficiency calls for strict moderation in all things during the working day. The time is now past when the salesman was compelled to waste a large portion of his day doing business in a bar or billiard room. These places are all very well at certain times, but the office or shop is the place for business and it should be kept there.

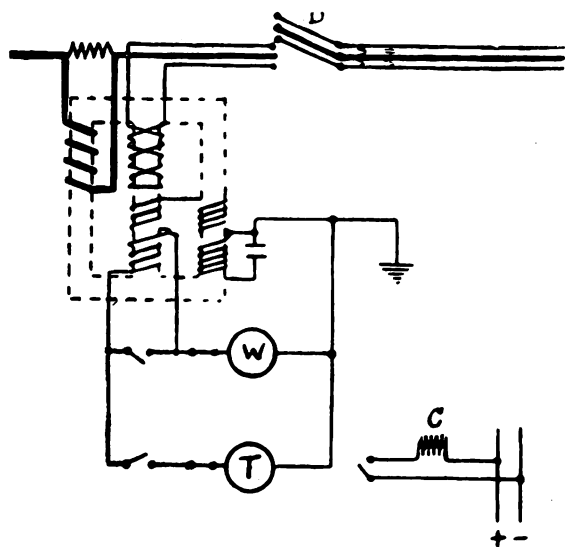
A salesman must be adaptable, within reason, to the moods and peculiarities of his customers. Some buyers prefer familiarity—others do not. The lesson is that the salesman should know his man as thoroughly as he knows his proposition. It is important to endeavor to remember the names of customers and buyers, for it is not flattering to be addressed incorrectly or to hear one's name wrongly pronounced.

The two last and very important points are that a salesman must not allow himself to be discouraged by failure, and that he must have an absolute belief that the work on which he is engaged is essential to his own success, the good of the electrical industry and the benefit of society in general.

In the course of a lecture delivered at the Engineering and Scientific Club, Wolverhampton, England, on Dec. 11, Mr. F. H. Rosencrants described boiler units working in the U.S.A. with capacities of 200,000 and 300,000 lb. of steam per hour. At the works of the Ford Motor Co. there are boilers now undergoing alteration which will be capable of evaporating 500,000 lb. per hour. Many of these large units are fired with pulverised fuel and give efficiencies around 90 per cent under ordinary working conditions. Two remarkable features of these large installations are the cleanliness maintained in the boiler house and the simplicity of control. There is an entire absence of dust and dirt, and under ordinary conditions one man is able to control four boilers.

The Pfannkuch Cable Protective System

Many different systems of protection for underground cables are in use, each claiming certain advantages. Brief reviews of several were given in this journal in February, 1925. In most cases the protection is very sensitive; so that a comparatively slight fault will cut the cable out of service. In general the protective devices operate on the current balance principle, i.e., so long as the ingoing current to the cable is the same as the outgoing current the tripping relays will remain inert, but as soon as a difference between these currents arises the balance is upset and the apparatus comes into operation. A system of this nature



Connections of Pfannkuch System
 D—Disconnecting Switch.
 W—Warning Relay.
 T—Tripping Relay.
 C—Circuit Breaker Trip Coil.

requires some means of communication between the instruments at the two ends of the cable. For this purpose use is made either of pilot wires or of special construction of the cable conductors. The installation of pilot wires is obviously likely to be expensive, and in some instances the special cable construction which overcomes the necessity for pilot wires is also expensive.

The Pfannkuch cable protective system, which has been developed by the Allgemeine Electricitäts Gesellschaft, does away with the necessity for pilot wires and at the same time uses a cable that is practically no more expensive than ordinary cable. The system is suitable for pressures from 10,000 volts upwards, and it has a great advantage in that it indicates an incipient fault before the earth leakage becomes great enough to warrant cutting the cable out of service. This gives the operators an oppor-

tunity of investigating and making repairs without having the inconvenience of a sudden involuntary shut down, for it has been found that it often takes several hours and sometimes days or weeks for a fault to develop to serious dimensions. Should a considerable fault develop rapidly, however, the protective system will cut the cable out of service and thus prevent damage to plant and equipment.

The cable itself is very similar in construction to an ordinary cable except that in each conductor every alternate wire of the outer layer of strands is insulated. These insulated wires are divided into two groups so that odd wires are in one group and even wires in the other.

The wires of each group are permanently connected in parallel at the ends of the cable. The bare wires which interleave these insulated wires are connected with the main core.

At each end of each phase of the cable is a specially designed current transformer with a three-limbed core. One limb carries a primary winding connected permanently in series with the core conductor and in parallel with a shunting resistance. On a second limb are two h.t. secondary windings each having the same number of turns but wound in opposite directions. These are connected one each to the groups of insulated wires around the cable core, and the voltages thus set up in the wires are balanced by connecting the transformers at the two ends of the cable in opposition. By means of the coupling through the transformers the main current is caused to divide up in the core and the outer layer wires in proportion to the conductivities of the respective circuits, just as though the strands were all connected in parallel. Thus the whole of the strands, insulated and bare, share in carrying the load current. On the second and third limbs of the transformers there are low tension operating secondary windings which are connected to the relays. These windings also are connected in opposition, so that normally the relays receive no current.

The operation of the system depends on the fact that if the insulating covering of the outer groups of wires surrounding the main cable core is damaged by any means that would give rise to a fault, a circulating current will flow between the groups. This will upset the flux distribution in the transformers, disturbing the balance in the second and third limbs, and allowing current to flow through the low tension windings. Two relays are connected in the low tension circuit. The first gives a warning if a slight fault occurs. At the same time it closes the secondary circuit through the second relay,

switches in an additional winding on the transformer secondary, and disconnects itself. The additional turns switched in to the secondary winding cause a drop in the secondary current induced by the fault to a value that will not operate the second relay unless the fault is serious. When the second relay operates it closes the tripping circuit of the main oil switch, thus cutting the cable out of service, and at the same time cuts itself and the transformer secondary out of circuit. The two relays are usually made up in one case and each gives visual indication of operation.

The isolating switches at the ends of the cable are made up in three pole form so that they interrupt the main core circuit and the groups of insulated strands at the same time. In order to ensure full discharge of all sections when the cable is earthed, bridging resistances are permanently connected between the insulated sections and the main core. Condensers are combined with these resistances to give voltage-

rise protection for the outer strands. Owing to the position of the outer strands considerable capacity currents may flow and these might cause the warning relay to operate. In order to guard against this a compensating condenser is connected across one of the transformer low tension secondaries.

It is claimed that this system is so sensitive that the warning will operate on fault currents of one per cent of normal load current. In addition it has an advantage in that positive location of the fault is simple owing to the connection made between the two groups of insulated strands. This obviates the necessity of burning out the fault in order to make it visible. It has been found that faults can generally be located to within a few centimetres and a single opening of the cable, without actually cutting it, is often all that is necessary.

Further information about this protective system may be obtained from Mr. H. Scott, 486 Bourke street, Melbourne.

Fault in Submarine Cable

A fault occurred recently on one of the Bass strait submarine telephone cables which form the means of signal communication between Victoria and Tasmania. It was located at 64 nautical miles from the Victorian end of the line, where the cable lies in 46 fathoms of water. The defect showed as a small puncture in the insulation of the core, but there was no means of ascertaining what gave rise to the trouble. The faulty section was cut out and a new piece of cable jointed in.

There are two cables across Bass strait, each approximately 190 nauts in length. Over the greater portion of their length they are about 15 miles apart, but they converge at the shore ends. The Victorian landing is at Flinders and the Tasmanian landing at Low Head. The cables are identical in construction. Each core consists of stranded copper with weight of 130 lb. per naut, insulated with gutta percha of the same weight. This is taped over with brass and textile tapes as a protection against teredo, and is served with tanned hemp. Each cable has three classes of protective sheathing. The main portion is armored with 10 galvanised iron wires each 0.192 in. diameter, and has a total weight of 3.69 tons per naut. For 10 nauts at each shore end there is added over this an outer sheath of 14 galvanised iron wires each 0.3 in. diameter, with layers of yarn and asphaltic compound between the sheaths, bringing the weight up to 14.6 tons per naut. Between the

shore ends and the main cable there are 10-naut intermediate sections having a single sheathing of 10 galvanised wires each 0.276 in. diameter, with weight of 7.32 tons per naut. Over the sheath in each case is a serving of tarred yarn and asphaltic compound. The conductor resistance of each cable is 9.1 ohms per naut at 75 deg. F., the electrostatic capacity is 0.333 mfd. per naut, and the dielectric resistance is 1,500 megohms per naut at 75 deg. F.

The cables were manufactured by Messrs. Siemens Bros. and Co. Ltd., of London, and were laid in 1909. In the 17 years of their service only three faults have developed, and the present failure is the first that has occurred in the deep sea section. Such a performance speaks well for the excellence of the manufacture. A fault on a communication cable causes great inconvenience, and there is sometimes a tendency rather hastily to blame the makers. But after all, the manufacture of a continuous sheath of insulation that will stand up for such long periods to the arduous conditions of submarine service is a remarkable achievement, and it is surprising that more faults do not arise.

The industrial dispute which was holding up the Shannon hydroelectric scheme in Ireland has been terminated by the dockers deciding to discharge vessels carrying constructional materials from Germany.

Wellington Tramways and Electric Supply

The tramway and electric supply undertakings at Wellington, N.Z., are in the hands of the city corporation. The trams are operated from a 500-volt d.c. trolley, part of the power being purchased from the electric light department and part generated at a d.c. power station. The tramways department distributes a certain amount of direct current energy for industrial purposes in the city. The electric lighting department generates its energy at a new power station at Evans Bay, and distributes at 100 volts, single phase, and 400/230 volts, three phase a.c. The report of these departments for the year ended Mar. 31, 1925, has recently been issued. During the year small extensions were made in the tramway system, the Thorndon Quay line being duplicated and a new single track constructed in Johnston street. Additions to the rolling stock were made by constructing 10 new cars, bringing the total number of cars up to 161. The following statistics cover the operations of the tramways during the period:—

Population served	105,000
Car miles run	3,462,400
Passengers carried	40,265,600
Electrical energy purchased, kelvins ..	11,000,000
Energy generated, kelvins	2,000,000
Energy used for traction and car lighting, kelvins	8,400,000
Passengers per car mile	11.63
Energy consumed per car mile, kelvins ..	2.43
Gross revenue	£410,983
Working expenses	314,314
Interest	34,802
Sinking fund	8,398
Renewal and reserve funds	35,237
Special appropriations	5,477
Net credit balance	12,755
Percentage working expenses to revenue	74
	d.
Revenue per car mile	28.48
Working expenses per car mile	21.78
Total expenditure per car mile	27.75
Route length of track, miles	28
Total h.p. of industrial motors supplied	10,662
Units sold for power purposes	4,021,400

In the electric supply department there has been considerable activity in completely re-organising the generation and distribution systems. A new power station has been erected at Evans Bay, a new substation built at Jervois Quay and an automatic converter station established at Newtown. The distribution system is in course of change-over from 100 volts single phase to 400/230 volts, 50 cycle, three phase a.c. Statistics of the operation of the undertaking during the year are as follow:—

Units generated	26,702,330
Units sold—	
Tramway supply	11,195,080
Private lighting	5,680,190

Units sold—

Power	716,860
Heating	1,984,300
Public lighting	611,900
Number of consumers—	
Lighting	16,857
Power	460
Heating	8,265
Capital expenditure	£653,703
Gross revenue	209,611
Working expenses	116,149
Interest	26,263
Sinking fund	7,318
Renewal and reserve funds	19,416
Special appropriations	20,520
Net credit balance	19,945
	d.
Average revenue per unit sold	2.43
Average working expenses per unit sold	
sold	1.38
Average capital charges per unit sold ..	0.63

The combined results of the operations of the two departments show a net surplus of £32,700. This, coupled with the steady expansion of business that has taken place, cannot but be regarded as very satisfactory. Mr. M. Cable, M.I.E.E., is general manager of the two departments.

EXTENSION OF ELECTRIC SUPPLY IN TASMANIA

The Electrolytic Zinc Co. has asked the Tasmanian hydroelectric department to extend the Queenstown-Zeehan transmission line for a distance of 17 miles to take in Williamsford, Hercules and Rosebery. The company is about to extend its operations on the Rosebery mines, and has asked that work on the transmission line be begun at once as it desires to have power available at the earliest possible date. A contract is being drafted and a bill is to be introduced to parliament to authorise the necessary expenditure, estimated at £19,000. Power for the Zeehan supply is purchased in bulk by the hydroelectric department from the Lake Margaret hydroelectric station of the Mount Lyell Mining and Railway Co., near Queenstown.

It has been decided to make a deviation in the new tunnel at the hydroelectric construction works, Lake Coleridge, New Zealand, on account of the fall which took place on Oct. 2, when three men were killed. Work is being commenced about two chains back from the fall and a curve to the right will be made. The deviation will not affect the efficiency of the tunnel, as the men were engaged on constructing a curve when the fall took place. The new line of the curve will be on an angle of about 20 degrees, which is about 10 degrees less than that of the original tunnel. It is expected that the work will be completed within contract time despite the fact that operations were suspended for nearly a month.

ELECTRIC SUPPLY AT AUCKLAND, N.Z.

The Auckland electric power board controls the supply of electrical energy over an area of 295 sq. miles with population of 150,000. It operates a steam generating station at King's Wharf, in the city of Auckland, but is making arrangements to purchase practically all its power requirements from the Horahora and Arapuni hydroelectric undertakings of the public works department when sufficient energy from these sources is available. During the year ended March 31, 1925, a considerable expansion of the board's services was recorded. The capacity of the King's Wharf station was brought up to 25,000 kw. by the installation of a 5,000 kw. generating set; 60,000 yd. of underground cable were laid, 1,014,000 yd. of overhead conductors were strung, 7,122 poles were erected and 5,864 new consumers were connected. A new tariff for domestic supply was introduced during the year. The charges under this are: For the first 25 units consumed in any six-weekly period, 5d. per unit; for the next 25 units, 3d. per unit, and the balance at 1½d. per unit. These rates are all subject to 5 per cent discount for prompt payment. In addition a special tariff for continuous service water heating has been introduced. At the end of the year installations of electric stoves totalled 150 and of hot water services 270. During the year the board opened a showroom for the purpose of co-operating with the electrical trading houses in making the advantages of domestic electrification more widely appreciated.

The financial position of the board is very satisfactory, a net profit of £19,508 having been realised on the year's operations. The gross revenue amounted to £327,245, the working expenses totalled £148,420, and the capital charges were £159,317. Statistics of the year's operations are as follow:—

Year ended March 31, 1925:—	
Units generated	46,853,560
Units sold	36,599,488
Maximum demand, kw.	13,000
No. of consumers	22,206
Load factor, per cent	41.1
Revenue from—	
Lighting	£106,573
Domestic power	42,562
Public lighting	4,832
Industrial power	70,293
Traction	93,572
Meter rents, etc.	9,413
Working costs—	
Generation	85,474
Repairs and maintenance	16,136
Distribution	22,313
Public lamps	1,487
Management	14,326
Special charges	8,684
Revenue per unit sold	2.14d.
Cost per unit generated	1.58d.
Cost per unit sold	2.01d.

ELECTRICITY IN SYDNEY, 1926

In accordance with the usual practice, Mr. S. Y. Maling, acting general manager of the electricity supply department, Sydney city council, has prepared estimates of receipts and expenditure for the year 1926. These predict a net profit of £160,935 at the end of the year. The figures, of course, are liable to alteration, due to unforeseen happenings affecting the operations of the department, principally the conditions obtaining in outside industries which constitute the chief source of revenue. Serious trade depression or boom, strikes, etc., all have appreciable effect. Subject to the effects of these conditions the estimates are as follow:—

Capital Expenditure—

Mains—

Additional mains, public lighting and services, to deal with normal increase in demand	£390,000
Replacing overhead high tension mains with underground mains	506,000
Distribution developments, 33,000 volt system	502,000
	£1,389,000
Substation equipment, etc.	187,434
Power house, Pyrmont	38,273
Power house, Bunnerong	200,000
Total ..	£1,823,707

Kilowatt Hours Sold—

Estimated number of units sold .. .	244,020,000
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Revenue—

Sales of current for all purposes ..	£1,903,595
Hired motors	35,000
Meter rents	8,980
Miscellaneous receipts	7,000
Total ..	£1,954,575

Expenditure—

Working expenses—

244,020,000 kilowatt hours at 1.1d.	£1,118,425
Gross surplus	£836,150

Capital Charges—

Interest	£381,000
Depreciation	244,020
Sinking fund	50,195
	£675,215
Estimated Net Surplus	£160,935

Steady progress is being made with the Sydney city railway and it is hoped that the section of line between Redfern and the new St. James' station will be complete by June next. The line runs underground on most of the route and is intended to give connection between the present railway system and Circular Quay, with intermediate city stations. Ultimately connection will be made with the North Shore across the harbor bridge, when it is built.

HYDROELECTRIC SCHEME FOR NITROGEN FIXATION IN N.Z.

Some few months ago a Wellington syndicate endeavored to obtain from the New Zealand government a license to utilise the scenic Bowen falls in Milford Sound for a hydroelectric scheme in connection with the fixation of atmospheric nitrogen. The application was rejected on the grounds that the works would destroy the beauty of the location. The syndicate, however, has now obtained a license for a scheme on Smith Sound. Authority has been given for the use of the falls, rivers or streams discharging into Smith Sound from Lake Manapouri, and for the erection of power lines in certain parts of the Fjior county. The term of the license is 60 years, and the development of 300,000 h.p. is authorised.

The application states that 50,000 h.p. will be taken in Deep cove, on Doubtful inlet, and a further 250,000 h.p. developed later from Lake Manapouri. The government has stipulated that the first portion of the work must develop 25,000 k.w., or have had spent upon it a sum of not less than £100,000, within seven years. A second stipulation is that the Lake Manapouri license will expire unless at least 50,000 h.p. is developed within 15 years. In addition the government requires an assurance that the cost of power at the syndicate's power house will not at any time exceed 1d. per unit. Finally, satisfactory assurances are required that the fauna of the district will not be interfered with, and that the natural scenic features will not in any way be disfigured.

The government table of available water power resources of the Dominion contains reference to the possibilities of Lake Manapouri. The available discharge of the lake into Smith Sound is 8,400 cusecs at a head of 600 ft. From this it is estimated that 630,000 kw. can be developed. This is the second largest scheme shown in the table, the largest being the Lake Te Anau project. The latter lake discharges 12,630 cusecs at 700 ft. head into George Sound, and a development of 1,200,000 kw. is possible.

Lake Manapouri has an area of 50 sq. miles and attains to a depth of 1,400 ft. Among the headworks entailed in the power development is the drilling of a tunnel 30 ft. in diameter for a distance of $6\frac{1}{2}$ miles. It will be seen that the syndicate proposes to develop less than half of the potential power, but this in itself, it is stated, will be the largest hydroelectric development in the southern hemisphere.

At the Sound deep water is available from the open sea to within a few feet of the proposed plant site, while close by is a raised marine flat of some 300 acres of excellent land on which the works and community will be established.

Within a short distance a very extensive occurrence of high grade marble has been discovered, and this find has enhanced the value of the scheme considerably. The outcrop is proved over a considerable area and has been analysed, giving 98 per cent of carbonate of lime. As lime of this quality is a necessary concomitant in the manufacture of artificial manurial nitrates from the air, its occurrence so close to the proposed scheme is fortunate.

The estimated cost of the development is in the neighborhood of £5,000,000. It is considered that power will be made available at about £1/5/- per h.p. per annum.

DEVELOPMENT OF NATURAL STEAM RESOURCES

An article in a recent number of the Electrical Engineer described some investigations of natural steam resources that were being made at Geyser Canyon, California. According to the Electrical World these investigations are now being carried further forward. Seven bores have been sunk to tap the steam and the indications are that there is sufficient steam available for a development of about 50,000 kw. The test wells range in depth from 260 ft. to 550 ft. and the pressure of the steam with the wells capped ranges from 62 to 276 lb. per sq. in. in different wells. The average steam supply from four of the wells is 25,000 lb. per hour at a gauge pressure of 100 lb. per sq. in. In the opinion of geologists the supply is permanent. The steam is remarkably pure, but investigations are being carried out with a view to determining what corrosive action it may have.

Preliminary plans are being made for developing electrical energy with a 10,000-kw. or 15,000-kw. low pressure turbo-generator installation. If sufficient cooling water is available the machines will be run condensing. The first cost of the plant will be about the same as that of an ordinary steam power plant with boilers, owing to the expense of drilling the wells, but the operating costs will be much lower. The power developed will probably be transmitted to the existing power systems and sold in bulk. If this installation proves successful, attention may be turned to other places in northern California where natural heat energy is in evidence.

The new electric tramway through Swanston street, Melbourne, was opened for traffic on January 24. This line provides a connecting link between the northern and south-eastern electric systems in the metropolitan area. Trams are now through-routed from Coburg or Preston on the north to St. Kilda on the south, a distance of 12 miles.

ELECTRIC BREAD BAKING

Considerable advances have been made in recent years in the design of electric ovens for bakers. At a recent exhibition at Grenoble, France, ovens of three types were on view, designed respectively for bread, pastry and biscuit baking. The manufacturers are the Societe Generale de Fours Electriques, of Grenoble, a firm that specialises in such equipment. The bread oven has two baking chambers, giving a total baking surface of about 130 sq. ft. The maximum energy consumption is 60 kw. and the oven will bake 480 lb. of bread per hour. The average consumption of energy varies from 0.1 to 0.136 kelvins per pound of bread. The external dimensions of the oven are: width about 8 ft., depth 11 ft. and height 8 ft., and the total weight empty is about five tons.

The pastry oven also has two chambers, one 6 in. and one 10 in. high. There are two baking plates which run into and out of the oven on trolleys. The maximum loading is 22 kw. The biscuit oven is of the continuous type, the biscuit trays sliding in at one end and out at the other. Its capacity is 880 lb. of biscuits per hour, with a maximum loading of 65 kw. The bread and pastry oven are designed for a maximum working temperature between 570 and 660 deg. F. They are fitted with pyrometers and control switches, and each has attached an electrically heated steam boiler for providing steam in the baking chambers as required.

At Croydon, England, a demonstration was given recently of a Magnet bread baking oven manufactured by the General Electric Co., Witton. It is a quarter sack size, loaded to 10 kw. and bakes a batch of bread in 40 minutes. Starting from cold it takes two hours to heat to the working temperature of 500 deg. F. The energy consumption works out at approximately 12 lb. of bread baked per kelvin.

Apart from the question of economy in actual running costs there are many advantages in electrical baking. In the first place the perfect temperature control ensures uniformity of the product. Also it has been found that the loss of weight during baking is less with the electrical than with any other method. Another factor is the heat conservation, which not only conduces to economy but gives comfortable temperature conditions in the bake house. Wages, rent for space occupied, cost of oven foundations and many overhead charges also come into account, apart from general convenience. A factor that weighs considerably with the consumer is the absolute cleanliness of the method. This may be turned to good account in advertising, and with some types of oven it is possible to operate in view of the public in a show window or demonstration room. The

very fact of advertising that the product is baked by electricity is a considerable attraction to many customers.

The first cost of equipment is the strongest factor militating against the general adoption of the electric method, but this is largely offset by the reduction in building expense, particularly in a new installation. The savings in running expenses and overhead charges with electric baking have been proved in practice to be very considerable. The economical application of the electrical method is not limited to large installations, indeed the use of electricity is a means for enabling the small tradesman to meet competition from large concerns.

THE DAM ACCIDENT IN NORTH WALES

The Electrical Review gives a detailed report of the unfortunate occurrence in North Wales on Nov. 2, when, owing to the bursting of a dam, portion of the village of Dolgarrog was washed away and 16 lives were lost. The accident occurred on one of the hydroelectric developments of the North Wales Power Co. There are two power plants at Dolgarrog: an old d.c. station and a new 10,000-kw. a.c. station. The driving energy is obtained from water storages on some of the tributaries of the Conway river. One of the principal storages is that at Llyn Eigiau, a natural lake the capacity of which has been considerably increased by the erection of a concrete dam. On the night of Nov. 2 a washout occurred beneath the dam, making an opening some 45 ft. long and 10 ft. deep through which the contents of the top 20-ft. depth of the lake issued. The water swept down into a subsidiary storage known as the Coedty reservoir, but the volume was too great for the capacity of this storage. Consequently the water flowed over the crest of the Coedty dam washing away the earth backing and exposing the 30-in. concrete core wall. The wall was unable to stand the strain, and gave way, precipitating the mass of water on to the village 500 ft. below.

The actual damage caused to the power plant was very slight and it was possible to restore electric service to the district from other water storages and other generating plants in a very little time. Some little damage was done to the works of the Aluminium Corporation, which takes supply from the Dolgarrog d.c. station. Extensive repairs will, of course, be necessary at the dams but, apart from the very regrettable loss of life the damage is not as great as might have been expected.

In connection with the electrification of the Sydney suburban railways a trial run with electric traction has been made on the Illawarra line.

Radio News

The Radio Broadcasting Co. of New Zealand Ltd. has asked for an extension of time till June 30 for the erection of its new stations at Auckland and Christchurch. The equipment is expected to arrive from England in May.

The number of radio listeners licenses in New Zealand at March 31, 1925, was 4,180. Since that date a 30/- license fee has been imposed and this, coupled with the fact that the new broadcasting company has not yet commenced to give services, makes it probable that the number is now considerably reduced.

An exhibition of radio and electrical apparatus, under the auspices of the Electrical Employers' Association, will be held in the Sydney town hall commencing on May 3. A special feature will be the display of domestic electrical appliances.

Preliminary plans have been approved for the building to house the new broadcasting station at Auckland, N.Z. The structure will be of two stories and will house the studio and all transmitting apparatus. The masts for the antenna will be erected on the roof. They will be of lattice steel construction 104 ft. high.

Serious interference with radio reception is reported from Wellington, N.Z. It takes the form of a continuous ripping noise which is at its worst on a wave length between 250 and 300 metres. Observations show it to be worst when there is drizzling rain, pointing to leakage from h.t. overhead power lines in the city as the cause.

A HETERODYNE PHENOMENON

Users of heterodyne circuits may have noticed an interesting phenomenon that occurs when selecting a suitable note to listen to by varying the wave length of the local oscillator. When the heterodyne is oscillating at the same wave length as the incoming signal no note at all is audible. Theoretically, it might be supposed that it is only at one exact wave length on the heterodyne that the note fades away entirely, i.e., the note in gradually falling down the scale of audible frequencies will ultimately arrive at a note which is inaudible, but that as the wave length of the oscillator continues to be varied uniformly, this inaudible note will almost immediately become audible and begin climbing up the scale of audible frequencies. But in actual practice this is found not to be so. The

note falls uniformly until it reaches a certain value, but after reaching that value it suddenly becomes inaudible and a large variation in the apparent wave length of the oscillator has to be made in order that the note should again become audible; also, when it does become audible again it is at a note which is considerably above the lower limit of audibility.

The explanation of this phenomenon is that when the wave length of the local oscillator approaches sufficiently near to that of the incoming signals the two wave lengths will pull into synchronism, just as two alternators will pull into synchronism when paralleled at slightly different frequencies. This synchronism of the oscillatory circuits may be broken again only when a sufficient difference is made between the wave lengths of the circuits. The point at which the interaction of the waves causes synchronism is dependent upon the relative strengths of the signals, and the tightness of coupling between the oscillators.—“Electrical Times.”

BROADCASTING LICENSE FEES

Since the inception of wireless broadcasting in Australia the amount collected in license fees throughout the Commonwealth has totalled £179,720. The percentages of the total collected from the various states are as follow:—New South Wales 49.4, Victoria 34.3, South Australia 7.1, Western Australia 5.0, Queensland 3.3, Tasmania 0.9.

Up to December 31, 1925, the following amounts had been paid to broadcasting companies:—

Farmer and Co. Ltd., Sydney	£53,530
Broadcaster's (Sydney) Ltd.	22,941
Broadcasting Co. of Australia, Melbourne ..	31,078
Associated Radio Company, Melbourne ..	13,442
Queensland Government, Brisbane	1,785
Central Broadcasters' Ltd., Adelaide	8,408
Westralian Farmers Ltd., Perth	7,673

Total £138,859

CONTROL OF BEAM WIRELESS

It is expected that the beam wireless service between Australia and Great Britain will be given a first test in June or July next, and that commercial operation will be inaugurated in September. A staff of operators for the Australian station is now undergoing training in England. Control at the Australian end will be in the hands of Amalgamated Wireless (Australia) Ltd., but it appears that the British end may be operated by the postal department. Strong representations have been made to the British government to allow Australian control at both ends, but so far no advance has been

made. Mr. G. M. Allard, chairman of Amalgamated Wireless, who represents the federal government on the board of the company, recently returned from England after an endeavor to impress the government with the necessity for all-Australian control of an Australian wireless service. He states that all that is asked is the right to equal facilities to those enjoyed by the great cable operating concerns. It is probable that the federal government will make representations to the British government and endeavor to obtain control of this important service.

SIMULTANEOUS TUNING OF OSCILLATORY CIRCUITS

In general broadcast receivers are operated by persons having little or no technical knowledge and it is therefore an advantage to have the control as simple as possible. For the reception of near-by stations, where only audio amplification is required, one or two tuning controls are usually all that are necessary, but when distant stations are to be tuned in, and a couple of stages of radio amplification are used, the control is liable to become more complicated and somewhat delicate. Amongst appliances that have been introduced in order to simplify this control is the dual variable condenser, which may be used to tune simultaneously two similar oscillatory circuits. The device consists of two condensers accurately matched for capacity, with the moving plates mounted on and operated by one shaft.

A drawback to the use of a condenser of this type lies in the fact that, however carefully the two oscillatory circuits may be built and matched there is always a liability that their characteristics will be different owing to slight differences in the length and spacing of the wiring. This can be overcome by the use of a balancing condenser which may be connected to the dual condenser and operated to balance the capacities of the two oscillatory circuits. The balancer is of very small capacity and has two sets of fixed plates and one of moving. Capacity may be added to either circuit as desired by adjusting the relation of the moving to the fixed plates. Once the circuits have been balanced the balancer needs no further adjustment and the tuning can be carried out on the dual condenser. The Igranic Electric Co. Ltd., London, is manufacturing both these devices, with material and workmanship that guarantee good service.

Telephony and Telegraphy

A new loaded telegraph cable is being laid for the Eastern Extension Telegraph Co. between Cocos island and Fremantle, W.A. The length of the cable is 1,800 nauts and the speed for which it was designed 2,100 letters per minute.

During the half year ended Dec. 31, 1925, 30,596 new telephone connections were made throughout the Commonwealth. This is an increase of 1,841 over the connections during the previous half year.

The P.M.G.'s department intends to remove the overland telegraph circuit between Adelaide and Perth from the present coastal route to a location adjacent to the transcontinental railway. New copper lines will be erected instead of the present galvanised iron wires. It is expected that the removal will effect economies in maintenance as well as saving 200 miles in the distance. At a future time the carrier wave system is to be installed. This will make possible telephonic communication between Perth and the eastern states.

Trade Notes

Town Lighting Ltd. has been floated with £10,000 nominal capital to acquire from E. P. Keatinge the electrical franchise of Bombala, N.S.W., and to trade as an electric light and power company in all branches. The registered office is at 25 O'Connell street, Sydney.

Western Electric Co. (Australia) Ltd. has been formed in New South Wales with nominal capital of £100 to manufacture telephonic, telegraphic, and electrical instruments. Mr. James Clarke, is a director and the registered office is in Castlereagh street, Sydney.

Measurement (Australia) Ltd. has been formed with authorised capital of £25,000 to acquire the Australian branch of Measurement Ltd. and to manufacture electricity meters. The first directors are: Sir Henry Cowan and Messrs. F. R. Smith, F. Thorp and J. A. Macleod. The registered office is in Sydney.

Business Getters.—The British General Electric Co. Ltd., Sydney, through its publicity department, has recently issued some attractive folders dealing with electric fans, irons, cookers, and domestic appliances. "Magnet" dealers can obtain supplies plus the addition of an overprint giving their name and address upon application.

Dissolution of Partnership.—The old-established electrical trading and contracting firm, Messrs. W. Cumming and Co., of Melbourne, has decided to dissolve partnership. Tenders have been called for the assets of the business, including: Furniture, fittings and plant at the city shop and Windsor workshop; agency, stock and goodwill of agency; stock of electrical goods; lease of Windsor premises; trade mark Celco; goodwill of business.

Westinghouse Senior Cabinet Range.—The Westinghouse Electric and Manufacturing Co., represented in Australia by the Australian Westinghouse Electric Co. Ltd., has recently placed on the market a new electric range known as the Senior Cabinet. It has an oven 18 in. high, 15 in. wide and 17½ in. deep equipped for automatic control, with two heaters rated at 1,800 watts each. There are four hot plates, two rated at 1,000 watts and one each at 1,500 and 1,800 watts. In addition there is a plug receptacle for taking any 1,000-watt appliance.

International Combustion, London, through their Australian office, Kembla building, Sydney, notify that they have just secured a contract of an approximate value of £250,000, covering four 60,000 lb. per hour boilers, together with the necessary buildings for Congella, Durban, South Africa. In addition, extensions are to be made including the removal and re-setting of two 60,000 lb. per hour boilers, also the equipment of the entire plant with the Lopulco system of pulverised fuel firing.

Westinghouse Achievements.—The Westinghouse Electric and Manufacturing Co., of U.S.A., has issued its illustrated brochure, "The Engineering Achievements of the Westinghouse Electric and Manufacturing Co. for the year 1925." The publication forms an interesting record of advances in electrical engineering practice during the past year. It contains brief descriptions of new plant and equipment covering a very wide range from heavy power equipment to instruments and household appliances.

Self-Contained Colliery Lighting Unit.—Messrs. Switchgear and Cowans Ltd., Manchester, are manufacturing a useful line of colliery lighting control units in the form of a combined oil switch fuse and transformer. The unit is used for reducing the pressure of a single phase supply to a voltage suitable for lighting, and for controlling the lighting supply. It consists of an oil immersed switch and fuses and an oil immersed transformer, the switch fuse being mounted on the side of the transformer tank. The units are made in sizes from 0.5 to 5 kv.a. The whole construction is flameproof and the parts are built to withstand severe service. The oil switch is of the double pole type, non-automatic and the fuses are of the h.t. cartridge

type. The switch and fuses control the h.t. leads, thus giving protection to the transformer as well as to the l.t. lines. The fuse compartment is covered with a hinged flameproof lid, which is interlocked with the switch handle so that the lid cannot be opened when the switch is on. Thus a fuse may be replaced in perfect safety without disconnecting the unit from the supply mains. Further particulars of the apparatus, and prices, may be obtained from Messrs. Horrocks, Roxburgh Pty. Ltd., Melbourne.

Fire-Resisting Cables.—Messrs. Johnson and Phillips Ltd., London, are manufacturing a line of fire-resisting v.i.r. cables in 300, 600 and 2,500 megohm grades and standard sizes. In these cables the ordinary taped rubber insulation is covered first with several laps of the highest quality asbestos paper. Over this is a strong flexible braiding of small steel wires, which in turn is covered with several more laps of asbestos paper. The whole is then covered with a braiding of special impregnated jute and finished in fire-resisting compound. The protective layers function both to protect the conductor from external conflagrations and to prevent the spread of flames from an internal arc. The firm is prepared to supply other types of cables, such as twin, three or four core or high tension cables, protected in a similar manner.

Royce Transporters.—The Victorian railway department has placed an order with Messrs. Horrocks, Roxburgh Pty. Ltd., of Melbourne, for two Royce transporters for use in one of the sheds at the Spencer street goods terminal. The transporters are each rated to lift 15 cwt. to a maximum height of 14 ft. They are constructed to run suspended from the lower flange of a 12 in. x 5 in. rolled steel joist, and they operate on a runway made up of these joists, which extends along the two sides and one end of the shed, with total length of 1,845 ft. Two totally enclosed slipring induction motors are used for the drive, one rated at 3 h.p. for hoisting and one of 5 h.p. capacity for traversing. The normal hoisting speed is 30 ft. per min. and the normal travelling speed 500 ft. per min. The attendant travels on the transporter and operates the equipment by means of two drum type controllers. The total weight of the machine is 4,500 lb. In addition to transporters of types similar to these, Messrs. Royce Ltd. manufacture electric cranes, capstans, winches and goods hoists, also generators, motors, switches and controllers. The firm is also prepared to quote on structural steelwork such as crane gantries, storage bunkers, steel frame buildings, etc. Messrs. Horrocks, Roxburgh will be pleased to give prompt attention to any enquiries along these lines.

New Electrical Appliances.—Messrs. Theo and Co. Ltd., of Liverpool, England, have forwarded particulars of several new electrical appliances. These include a wireless bed and foot warmer which is heated up by connecting to a plug or socket for fifteen minutes and then disconnected and used where required. It consists of a nickel plated cylinder $9\frac{1}{2}$ in. long by 3 in. diameter, and it is claimed that it will keep hot for several hours. Another useful appliance is the Theolight electric cycle lighting set, which is made in two types. No. 1 type consists of a small generator driven by the front wheel of the cycle with a built-in headlight forming a compact single unit. In No. 2 type there is a generator with separate head and tail lights. There is also the Theolight dynapocket lamp, consisting of a small generating and lamp unit worked by the pressure of the hand on a trigger. This outfit folds up into very small compass for the pocket.

Elda Steam-Electric Iron.—A new domestic electric appliance has recently been placed on the market, in the form of an iron which moistens the clothes while it presses them, thus doing away with the necessity for sprinkling. This useful function is performed by the agency of steam generated by the heat of the iron, which impinges on the fabric as the iron passes over it. The iron is similar in general construction to the ordinary electric iron except that the handle is large and hollow and there is a groove, along the bottom of which is a row of tiny holes, formed diagonally across the sole of the iron. Communication between the hollow handle and a small chamber in the sole above the groove is given through an adjustable valve. When the iron is in service this valve is opened by a turn of the thumb and finger so that water drips through into the chamber. The heat converts the water into steam which issues through the small holes in the grooved sole and moistens the cloth. The quantity of steam can be adjusted as desired, to suit the particular fabric being dealt with, by means of the water control valve. It is claimed that the even distribution and accurate control of the moisture make it possible to satisfactorily iron the most delicate fabrics without the least trouble. The price of the appliance is 37/6. Further information may be obtained from Messrs. Herbst and Son, 231 Elizabeth street, Melbourne.

The G.E.C. and Its Engineering Activities is the title of a handsomely bound and attractive brochure published by the General Electric Co. Ltd., of London, the largest electrical manufacturing concern in the British Empire. The volume is profusely illustrated and printed on heavy art paper, and its 100 pages are devoted to a brief outline of the history and achievement

of the company from 1887, when the first catalogue was issued, to date. Particular attention is directed to the Witton site which in 1901 was an expanse of meadowland. To-day, of the area of 120 acres occupied by the company, 35 acres is required for works and offices and a further seven acres for a well laid out sports field. Amongst the departments quartered at this site are: Main engineering, switchgear, carbon, standard motor, small motor and fan, transformer, battery, lamp, black moulded insulation, tool and hoist, development, foundry, power house, testing, plating, and enamelling and mica shop. Each of these is laid out on thoroughly scientific lines and furnished with modern machine tools, handling apparatus, etc. Short descriptions are given of the chemical laboratory, the Magnet club, the Fraser and Chalmers engineering works, Pirelli general cable works, Salford instrument works, Chamberlain and Hookham meter works, Peel Conner telephone works, Osram-G.E.C. lamp works, G.E.C. union works, and other subsidiary companies. The volume is in keeping with the high standard maintained by this firm and is well worthy of a place in any reference library.

Everhot Water Heaters.—Many electric supply authorities are now offering special low tariffs for energy supply for continuous water heating, and the result of this encouragement has been to considerably increase the number of installations of electric hot water service and to stimulate the manufacture of reliable and economical water heating apparatus. It is a great boon to have hot water always on tap in the home, and with an electrical installation this can be obtained at very reasonable cost. A typical example of the equipment now available is the Everhot water heating and storage system manufactured by Draffin Bros. Pty. Ltd., 346 Flinders street, Melbourne. The heater consists of a wire element wound on a porcelain cylinder and surrounded by a metal jacket through which the water flows. The space between the element and the inner tube of the jacket is filled with a compound which gives excellent transfer of heat from wire to water. The wire is worked at a temperature below red heat and this, coupled with the protection afforded by the filling compound makes for long life and great reliability. The elements are made in ratings from 200 watts upward, according to the requirements of the system. Storage of the hot water is provided in a tank lagged with hair felt, connected by a short pipe with the heater. The incoming water passes through the heater and flows in at the top of the tank. The draw off for the house service is taken from near the top of the storage so that the hottest water is available. The flow of water coming into the

system is regulated automatically by means of a ball cock according to the quantity drawn off. The heating element is always in circuit, and when no water is being drawn off the whole contents of the tank are kept hot by natural convection circulation through the heater. Storage tanks are constructed in sizes from 15 gal. upwards, according to requirements. The dimensions of tanks and the capacities of elements are so proportioned that with the rated draw-off per day the water is maintained at about 160 deg. F.

In addition to the systems for serving a whole house, Everhot heaters are made up in smaller forms for special service. There is a bathroom equipment with storage for 15 gal. and element rated at 200 watts or higher if required, and a kitchen hot water service with 100-watt element and 3-gal. storage. These last-named equipments are similar in principle to the larger systems. The running costs of the Everhot heaters are very reasonable owing to the low rating of the elements, particularly where the reduced tariff for continuous service is available. The prices of equipment range from £7/10/- for the kitchen system to £31 for a system with 50-gal. storage.

POSITIONS VACANT

The federal capital commission invites applications, closing February 22, for the position of electrical engineer, at a commencing salary of £600 per annum. Experience in the operation and management of an electric supply undertaking is a necessary qualification. The successful applicant will be required to take charge of general electrical design, construction, and inspection within the federal territory, and of the operation and maintenance of the commission's electric supply undertaking. Applications, closing on the same date, are also invited for a mechanical engineering draftsman at a commencing salary of £350 per annum, with experience in general mechanical engineering, designing and estimating, including ventilation, water heating, refrigerating, and air conditioning systems in buildings.

Applications are also being invited by the federal capital commission for the position of electrical draftsman, at a commencing salary of £400 per annum. The qualifications must include at least five years' drawing office experience, and the ability to prepare drawings and specifications for light and power in buildings, high tension substations and general electric supply works.

Lighting and Power

Albury, N.S.W.—It is expected that a full supply of electrical energy from the mains of the Victorian electricity commission will be available within the next three months.

Ararat, Vic.—The borough council has decided to purchase a 60 h.p. crude oil engine to augment the electric supply plant.

Bankstown, N.S.W.—The municipal council is extending its electric supply undertaking by the installation of two 50 kv.a., 11,000/415/240 volt transformers and additional reticulation.

Beechworth, Vic.—The shire council is applying for an order in council to enable it to undertake the supply of electricity in the town.

Bombala, N.S.W.—Town Lighting Ltd., with registered office in Sydney, has been floated to acquire the electric supply franchise for the town.

Bowral, N.S.W.—Acting upon the recommendation of the electrical engineer the municipal council has decided to reduce the domestic power charge from 4d. to 3d. per unit, and to place the industrial power tariff on a graduated scale in accordance with the horse power connected.

Box Hill, Vic.—The annual report of the Nunawading shire electric supply has been issued. The undertaking purchases energy in bulk from the state electricity commission and distributes at 400/230 volts three phase. During the last year, 403 new consumers for lighting and 291 for power and heating have been connected, bringing the total up to 3,810 consumers. The number

of units purchased during the year was 1,661,840 and the number of units sold 1,295,510. The maximum demand was 517 kw. This is lower than the figure for the previous year owing to the bulk supply of energy to the shire of Lilydale having been taken over by the electricity commission. The revenue for the year was £22,281 and the net profit £3,991. Mr. G. F. Wright is electrical adviser to the council.

Bunyip, Vic.—A proposal is afoot to ask the cool stores to install plant for giving electric supply to the town.

Carterton, N.Z.—The Wairarapa power board has adopted a new scale of charges for industrial energy supply: For motor installations of a total capacity of 4 h.p. and under, first 100 units per month 4½d. per unit, next 100 units 3½d., all over 200 units 2d. per unit. The board is raising a loan of £10,000 for extensions to its electric supply undertaking.

Coff's Harbor, N.S.W.—Mr. P. Burke has commenced supplying electricity in the town.

Coraki, N.S.W.—A proposal is afoot to construct at the Moonenbar coal mine, Bungawalbin, a power house for the supply of electricity in bulk to Lismore, Casino, Coraki, Woodburn and Ballina.

Corowa, N.S.W.—The bulk supply of electrical energy from the Victorian electricity commission's north-eastern district scheme has been switched on. The power is brought by a 6,600 volt transmission line from Wahgunyah and is stepped down for distribution in three substations. The low tension distribution is at 400/230

volts, three phase 50 cycles. The council proposes to introduce a two part tariff, which will have the effect of a reduction on the past rates for supply.

Flinders, Vic.—The state electricity commission is taking steps to give a bulk supply of electricity to the naval base at Crib Point. The energy will be transmitted by a high tension line running from Mornington through Somerville, Tyabb and Hastings. It is probable that taps will be taken from the line to give supplies along the route.

Geraldton, W.A.—Tenders closed with the municipal council recently for the supply, delivery and erection of two 110 kw. crude oil engines and for extensions to the power station building.

Gerrington, N.S.W.—A poll of ratepayers is to be taken on the question of the proposed electricity supply scheme.

Gisborne, N.Z.—The borough council is borrowing £20,000 for the installation of an additional generating unit at the power station.

Glen Innes, Q'ld.—Mr. E. A. Saral has been appointed engineer in charge of the electric supply undertaking in succession to Mr. W. Scott.

Greymouth, N.Z.—The power house building for the Grey power board is complete and the generating plant is in course of installation. Transmission lines between the power station and the town are being erected.

Huonville, Tas.—Electric supply from the mains of the hydroelectric department has been switched on. The energy is brought by a high tension line from Cygnet, crossing the Huon river by submarine cable. The distribution system is 400/230 volts, 50 cycle, three phase a.c. Glen Huon and Ranelagh are also supplied and Franklin will be linked up in the near future.

Jamestown, S.A.—An interesting position has arisen in connection with the disposal of the electric supply undertaking. The council has decided in favor of selling to the Adelaide Electric Supply Co., but a poll of ratepayers has voted 166 to 112 against this proposal.

Jerilderie, N.S.W.—The shire council's electric supply installation is now complete. The prime movers are a 15 h.p. and a 50 h.p. Paxman suction gas engine, and the distribution system is 415/240 volts, 50 cycle three phase a.c. Mr. J. F. Chapman is engineer and Mr. A. A. Perry, electrician.

Kadina, S.A.—The municipal council has decided to reduce the price of energy for power purposes from 8d. to 4d. per unit.

Koondrook, Vic.—The Kerang shire council has decided upon an electric supply scheme for the town. Energy will be purchased in bulk from the Wakool shire council.

Lawrence, N.Z.—A movement is on foot to obtain a supply of energy for the district, including Waitahuna and Beaumont, from the Otago power board.

Lismore, Vic.—The Ripon shire council has asked the electricity commission to extend the electric supply from Camperdown to Lismore, Skipton and Beaufort.

Lithgow, N.S.W.—The railway commissioners are taking steps to establish an electric generating station adjacent to the railway coal mine. Supply will be given throughout the district, and the cost of the scheme is estimated at £250,000.

Little River, N.Z.—The Banks Peninsula power board is carrying out afforestation works to provide for future requirements of distribution poles. During last year it planted 4,700 trees.

Maryborough, Vic.—The borough council has accepted the tender of Thompson and Co. of Castlemaine for a 150 kv.a. alternator for the electric supply plant.

Mt. Barker, S.A.—The Mount Barker Electric Supply Co. has gone into voluntary liquidation following the sale of its undertaking to the Adelaide Electric Supply Co. The company had been in operation for about three years and had achieved its object of providing adequate electric supply for Mt. Barker and Littlehampton. It had paid its way and concluded its operations with a good sale which allowed of a final dividend of 15½ per cent being paid to the shareholders.

Nagambie, Vic.—Mr. J. A. Carruthers, of Bendigo, has been appointed electrical engineer to the municipal council in place of Mr. A. Mather who resigned to take a similar post at Ouyen.

Nelson, N.Z.—The electrical engineer has recommended that installations for outside shop window lighting be supplied at a flat rate of £3/16/- per 100 watt lamp per annum, provided application is made for groups of not less than 10 100-watt lamps. The wiring is to be carried out by the consumers and the lamps lighted and extinguished by the council.

Ouyen, Vic.—The Walpeup shire council is taking steps to install an additional crude oil engine of 75 h.p. at the electric supply station.

Owen, S.A.—Electric supply is now available from the mains of the Adelaide Electric Supply Co. Energy is stepped down from the 33,000 volt line running from Gawler to Balaklava and is distributed at 400/230 volts, 50 cycle three phase.

Queenstown, N.Z.—The borough council is borrowing £1,200 for the completion of the hydroelectric scheme.

Rochester, Vic.—The power house of the Commonwealth Electric Co. Pty. Ltd. has been completely destroyed by fire. The plant included a 110 h.p. and an 81 h.p. suction gas engine and a 41 h.p. crude oil engine. The fire is stated to have commenced with an explosion at about 3 a.m.

Sheffield, Tas.—A recent poll of ratepayers gave a vote strongly in favor of taking electrical energy supply from the hydroelectric department.

Strathalbyn, S.A.—The municipal council is making extensive alterations to its power station, and has placed an order with the Southern Electric Power Co., of Adelaide, for a 90 h.p. two cylinder Vickers-Petters crude oil engine for belt driving an existing Westinghouse generator and a 25 h.p. single cylinder engine of the same make direct coupled to a 230 volt Thrige generator. The smaller set will run unattended if required.

Sunbury, Vic.—It has been arranged that the state electricity commission take over the electric supply undertaking of the Bulla shire council on May 1. The present suction gas plant is to be shut down and supply will be given by a transmission line linking up with the Melbourne primary distribution system near St. Albans.

Timaru, N.Z.—The South Canterbury power board is raising a loan of £67,000 for electric supply works in Levels county and Pleasant Point town district.

Torquay, Vic.—Application has been made to the electricity commission for a supply of electrical energy.

Unanderra, N.S.W.—The Illawarra Central municipal council has requested the public works department to proceed with reticulation for electric supply in the district. Port Kembla, Dapto and Figtree also are to be supplied. The estimated cost is £7,000.

Wagga, N.S.W.—The mayor and the council's consulting electrical engineer, Mr. G. B. Lincoln, have conferred with Mr. F. G. Carter, chief electrical engineer of the N.S.W. public works department, regarding the council's proposed agreement with the department for taking bulk energy from the Burrinjuck hydroelectric scheme. The council has decided to accept the agreement provided the term be ten instead of five years and

the council be allowed to retain the right to generate such portion of its power requirements as may be considered desirable. In addition an assurance is required that the price of bulk energy will not exceed 1d. per unit. The consulting engineer is drawing up the amended agreement for submission.

Wanganui, N.Z.—The Wanganui-Rangitikei power board is now giving supply to 3,143 consumers in the borough of Wanganui and to 4,185 in Marton, Bulls, Hunterville and the country districts. The connected industrial load is 1,980 h.p.

Wangaratta, Vic.—The electricity commission wishes to take over the borough electric supply undertaking and incorporate it with the north-eastern district electric supply scheme. At present the council purchases energy in bulk at 4d. per unit from the Wangaratta Woollen Mills Co. and retails it at 9d. and 5d. per unit for lighting and power respectively. Under this arrangement the council is enabled to make a profit on its operations. The commission wishes to purchase the bulk supply

undertaking from the woollen mills, the contract for which has some years to run, but not to purchase the generating plant. It wishes, also, to take over the distribution undertaking from the council and to impose a two-part tariff system instead of the present method of charging. Both the woollen mills and the council, however, are desirous of adhering to the present arrangement, at least until the expiry of the current contract. The woollen mills company does not feel inclined to dispose of the contract without selling the generating plant, and the council is of opinion that, in selling out to the commission, it stands to lose the profit it has been making from the electric supply, while gaining nothing for itself or the ratepayers. Investigations appear to show that under a two-part tariff a large number of the consumers would have to pay more for their energy than they do at present.

Wyangla, N.S.W.—The state public works committee is taking evidence on the Wyangla water conservation scheme in connection with which it is proposed to provide hydroelectric power to all centres in the Lachlan valley.

Current Prices for Electrical Supplies

The quotations in this list represent the average retail selling prices ruling in Melbourne during the month of publication. These prices are subject to bona fide traders' discounts. Special rates are obtainable in most cases for large quantities. In general Sydney prices are slightly lower.

Adaptors—

Hardwood	doz.	11/3
Parallel	each	6/6

Blocks—

3 in. round	gross	21/3
3½ in. round	gross	21/3
6 in. x 3 in. rectangular	doz.	6/3
9 in. x 3 in. rectangular	doz.	7/6
6 in. x 6 in. square	doz.	12/6

Bushes—

½ in. ideal metal	gross	7/6
¾ in. ideal metal	gross	7/6
1 in. ideal metal	gross	8/9
¾ in. plain wooden	doz.	1/6
1 in. plain wooden	doz.	1/8
1 in. plain wooden	doz.	2/

Bells and Bell Material—

Bell transformers	each	10/6
1½ volt dry cells	each	3/
Bell wire—1/029 d.c.c.	1,000 yd.	32/6
1/036 d.c.c.	1,000 yd.	42/6
1/029 d.c.c. and i.r.	1,000 yd.	50/
1/036 d.c.c. and i.r.	1,000 yd.	60/
No. 2 porous pots	each	2/
No. 2 jars	doz.	8/9
No. 2 zines	each	1/3
Salammoniac	lb.	1/3
2½ in. wood box bells	each	4/6
2½ in. iron box bells	each	4/6
3 in. wood (church gong)	each	18/4
Bell presses	from each	3/9

Pocket Lamp Batteries—

Batteries, pocket lamp	each	1/10
2-cell batteries	each	2/5
3-cell batteries	each	2/8

Ceiling Roses—

	English	Japan
2-plate	doz.	10/5
3-plate	doz.	13/9
		7/6

Connectors—

1-way, porcelain	doz.	2/6
2-way, porcelain	doz.	4/
3-way, porcelain	doz.	5/

Counterweights—

Porcelain	each	2/6
Brass	each	5/6
Shot for same	lb.	6½d.

Casing and Cover—

Best white pine	100 ft.	10/
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Conduit—

		Plain	Screwed
½ in.	100 ft.	8/9	20/
¾ in.	100 ft.	9/7	20/
1 in.	100 ft.	15/	27/6
1 in.	100 ft.	27/6	40/
1½ in.	100 ft.	45/	60/
1½ in.	100 ft.	68/	85/
2 in.	100 ft.	—	135/
¾ in. oval	100 ft.	12/6	—

Conduit Fittings—

		½ in.	¾ in.	1 in.
Grip—Tees	doz.	3/10	3/10	4/8
" Elbows	doz.	3/	3/	3/10
" Couplings	doz.	2/3	2/3	3/
" Crampets	gross	5/5	5/5	6/3
Saddles	gross	5/	5/	5/5
		1 & ¾ in.	2 in.	
Screwed tees	doz.	5/5	7/6	
" elbows	doz.	3/9	5/5	
" couplings	doz.	2/9	4/	
" bell mouths	doz.	5/	5/	
" " "	1 in.	doz.	14/10	
" " "	1½ in.	doz.	19/6	
" " "	1½ in.	doz.	27/	

Junction Boxes—

		¾ in. & 1 in.	2 in.
2-way	doz.	10/10	10/10
3-way	doz.	11/3	11/3
4-way	doz.	11/3	11/3

Fuses (Cut-outs)—

	British	Japan
5 amp, anchor type	doz. 10/	5/
5 amp, round chamber	doz. 17/6	8/9
8 amp, round chamber	doz. 20/	12/6
10 amp, oblong	doz. 35/	25/
20 amp, oblong	each —	3/

Holders—

	English	Japan
C/G., S/C. holders	doz 11/3	8/4
½ in. and ¾ in. holders	doz. 11/3	8/4
Batten holders	doz. 12/6	9/2

Lamps—

Metal Filament, Vacuum Type		
25 to 250 volts, 20 to 60 watt	each	2/
20 to 250 volts, 100 watt	each	5/

Gas-filled Type		
20 to 250 volts, 25 to 40 watt	each	2/9
60 watt	each	3/3
75 watt	each	3/9
100 watt	each	5/3
150 watt	each	7/
200 watt	each	9/
300 watt	each	13/
500 watt	each	17/6
750 watt	each	22/6
1000 watt	each	27/6
1500 watt	each	40/

Carbon Filament		
All voltages, 5 to 32 candle power	doz.	24/
All voltages, 50 candle power	doz.	42/

Plugs—

5 amp two pin plugs	doz.	27/6
5 amp two pin tops	doz.	12/6

Shades, Opal—

8 in.	doz.	10/
9 in.	doz.	12/6
10 in.	doz.	15/

Switches—

	English
5 amp s.p. pol. brass	doz. 16/3
5 „ s.p. ox. copper	doz. 17/11
5 „ 2-way pol. brass	doz. 30/

Switches—

5 „ 2-way ox. copper	doz.	33/
10 „ s.p. pol. brass	doz.	37/6
5 „ d.p. pol. brass	doz.	37/6
10 „ d.p. pol. brass	doz.	85/
5 „ s.p. ceiling switches	each	5/6
5 „ 2-way ceiling switches	each	6/6
1 „ ceiling switch and rosette	each	5/6
3 „ American tumbler	doz.	22/6
3 „ s.p. indicating rotary	doz.	24/
3 „ s.p. non-indicating rotary	doz.	22/6
3 „ 2-way rotary	doz.	56/3
5 „ d.p. indicating rotary	doz.	62/6
10 „ d.p. indicating rotary	doz.	75/
20 „ d.p. indicating rotary	doz.	150/

Switchboards—

	English	Japan
Single circuit marble 5 amp	each 9/9	8/
Single circuit marble 10 amp.	each 17/6	16/3
Two circuit marble 5 amp	each 19/2	15/10
Two circuit marble 10 amp	each 25/	22/

Switchboard Frames—

6 in. x 6 in. local make	doz.	9/6
6 in. x 8 in. local make	each	1/
8 in. x 8 in. local make	each	1/3
8 in. x 10 in. local make	each	1/6
10 in. x 10 in. local make	each	1/8

Tape—

Black adhesive	lb.	2/9
Pure rubber	lb.	15/

Wire and Cables—

	Per 1,000 yd.	
1/.044, 600 meg.	£7 3 4	+ 15%
1/.064, 600 meg.	10 5 0	
3/.036, 600 meg.	11 15 0	
7/.036, 600 meg.	20 10 0	
7/.044, 600 meg.	26 0 0	
7/.064, 600 meg.	43 10 0	

Flexibles—

	Per 100 yd.	
23/.0076 cotton	£2 5 0	+ 10%
40/.0076 cotton	2 16 8	
70/.0076 cotton	3 11 8	
110/.0076 cotton	4 13 4	

Electrical Contracts

Full information regarding contracts invited and accepted is published every week in "Tenders," a registered newspaper issued from the office of "The Electrical Engineer." Subscription, 20/- per annum.

COMMONWEALTH

Dept. of Works and Railways.—Motors for machine gun factory, Lithgow, N.S.W.—Noyes Bros. Ltd.; motors for telephone exchange, Elsternwick, Vic.—Noyes Bros. (Melb.) Pty. Ltd.; three elevators, C'wealth offices, Melbourne—Edmiston and O'Neill Pty. Ltd.; four electric motors for Adelaide G.P.O.—Siemens Pty. Ltd.; two electric motors for C'wealth offices, Adelaide—Siemens Pty. Ltd.

P.M.G.'s Dept., General.—Lamps, lamp caps and lamp sockets—British General Electric Co. Ltd.; cable—British Insulated and Helsby Cables Ltd.; cable, lead covered—Standard Telephones and Cables (A/sia) Ltd.; cable, lead covered—W.T. Henley's Telegraph Works Co. Ltd.; lead-covered cable—Glover, through High Commissioner; telegraph equipment, all states—Walters Electrical Co.; telegraph equipment—Siemens Bros. and Co. Ltd.; telegraph equipment—A. W. Hart and Co., through High Commissioner; telegraph equipment—British Insulated and Helsby Cables Ltd.; telegraph equipment—Precision

Engineering Co.; switchboard cable—Siemens Bros. and Co.; switchboard cable—Standard Telephones and Cables (Aust.) Ltd.; bells and buzzers—Sterling, through High Commissioner; bells and buzzers—New Systems Telephones Pty. Ltd.; bells—Ericsson Tel. Mfg. Co.; transmitters and associated parts—Ericsson Tel. Mfg. Co.; mouthpieces, etc.—Standard Telephones and Cables (A/sia) Ltd.; telephone receivers—British General Electric Co. Ltd.; motor generator sets and associated apparatus required in connection with city south, city north, city east, and Ashfield telephone exchanges, N.S.W., and the Canterbury and South Melbourne telephone exchanges, Vic.—Newton Bros. (Derby) Ltd.; carrier telegraph system, with initial equipment for 5 duplex telegraph channels, capable of extension to 10 channels, and with all necessary apparatus included, spare and reserve apparatus for use between Melbourne and Adelaide—Standard Telephones and Cables (Aust.) Ltd.; carrier telegraph system, with initial equipment for five duplex telegraph channels capable of extension

to 10 channels, and with all necessary apparatus, including reserve and spare apparatus for use between Sydney and Melbourne—Standard Telephones and Cables (Aust.) Ltd.

P.M.G.'s Dept., N.S.W.—Counter E.M.F. cell batteries—Automatic Telephones Ltd.; accumulator batteries and counter E.M.F. cell battery—Tudor Accumulator Co. Ltd.

P.M.G.'s Dept., Victoria.—6 tons cadmium copper wire (40 lb. per mile—2 tons; 70 lb. per mile—2 tons; 100 lb. per mile—2 tons)—British Insulated and Helsby Cables Ltd.

STATES

South Aust. Supply and Tender Board.—450 miles 200 lb. H.D. copper line wire—Elder, Smith and Co. Ltd.; 10,000 ft. No. 11 S.W.G. rubber-covered copper wire, 15,000 ft. No. 16, and 6,000 glass insulators, Hemingray No. 19—Unbehaun and Johnstone Ltd.; telephone train control electrical material—Unbehaun and Johnstone Ltd.; electro-mechanical signalling material—General Railway Signal Co. Pty. Ltd.; 40 long time burning lamps for electric signals—E. Treliving.

State Electricity Commission of Vic.—22,000 V. 3-core cable—Brit. Insulated and Helsby Cables Ltd., and Siemens Bros. and Co.; bare hard drawn copper cable—Brit. Insulated and Helsby Cables Ltd.

Victorian Public Works.—Installation electric light, Warrnambool technical school—W. Paget; installation electric light and power, Emily McPherson college of domestic economy—McDonald and Co.; installation electric lighting and local telephones, St. Kilda road police depot—John March.

Victorian Railways.—Cable (660 volt four core)—Johnson and Phillips Ltd.; air brake equipment and spares—Australian General Electric Co. Ltd.; cable, rubber insulated, 35 pair, 20 lb. conductor—Lawrence and Hanson Elect. Co. Ltd.; insulated copper wire—Brit. Insulated and Helsby Cables Ltd.; accumulator cells and accessories—Coates and Co. Pty. Ltd.

Victorian State Coal Mine.—Cable—bitumen covered 7.064—Enfield Cable Works; 7.044—Johnson and Phillips Ltd.; I.R. covered, 7.064—W. T. Henley's Telegraph Works; lamps, electric, E.S.M.F., 240 v., 60 watt, 1,000, delivered—Wm. McLean and Co., 1,000—Australian General Electric Co.

NEW ZEALAND

Auckland Electric Power Board.—100,000 yd. .0225 sq. in. section h.d. bare copper cable—National Electrical and Engineering Co..

Christchurch City Council.—Aerial cable for extension and reinforcement of mains—Rudge Electrical Co.; circuit-breakers for sub-stations—Tolley and Sons.

Marlborough Electric Power Board.—Transformers—A. D. Riley and Co. (Ferranti); sub-station switchgear—A. D. Riley and Co.

Railways Department.—Motors and starters for Ad-dington workshops:—Sect. 1: Parkinson (N.Z.) Ltd.—Motors (Parkinson), starters (Electrical Apparatus Co.).

Rangiora Borough Council.—500 electric lamps—British General Electric Co. Ltd.

Wairoa Electric Power Board.—Copper wire (4 tons No. 8 h.d., 1 ton No. 6 h.d., and 1 ton No. 12)—Samuel Brown Ltd.

TENDERS OPEN

COMMONWEALTH

Commonwealth Railways.—Feb. 23—14½ tons H.D. copper wire.

P.M.G.'s Dept., General.—Feb. 23—Insulating and adhesive tape. March 2—Condensers. March 9—Telephone cord circuit relays, instrument cords. March 16—Ring-ing generators and polechangers, power board equipment, Adelaide exchange. March 23—Magneto trunk switch-boards, telephone switches. March 25—Indicators.

P.M.G.'s Dept., Queensland.—Feb. 23—Accumulator plates, separators and dowels. July 6—Automatic tele-phone exchange equipment.

Works and Railways Dept.—Feb. 22—Electric elevator. STATES

N.S.W. Public Works Dept.—Feb. 17—Watertight plug and switch combination.

N.S.W. Railways and Tramways.—Feb. 17—1,500-volt d.c. switchgear. Feb. 24—Electric wires and cables. March 3—11,000-volt ironclad switchgear, 500 impedance bonds, electric car equipments (time extended). March 5—Time extended—Electric power house equipment. March 10—Stokers or pulverised fuel equipment, 2-3 ton electric goods elevators. April 21—Four motor generating sets, switch operating batteries.

Queensland Irrigation and Water Supply Commission.—May 15—1,000 kw. steam turbo alternator, and 750 kw. steam turbo-alternator.

State Electricity Commission of Vic.—Feb. 22—22,000 volt lightning arresters, 22,000 volt outdoor disconnecting switches. March 24—Synchronous condensers and acces-sory plant. March 29—Transformer and auxiliary ap-paratus for obtaining neutral point. April 12—Spec. 26/1 turbo-generators, transformers, switchgear, cranes and accessory plant for Sugarloaf-Rubicon hydroelectric scheme.

Victorian Public Works Dept.—Feb. 18—Installation of electric light at Geelong technical school.

Victorian Railways.—Feb. 3—Stranded copper cable, G.I. telegraph wire. Feb. 18—Portable dynamometer, milliameters, thermovoltmeter and milliameters. Feb. 24 —Motors and starting and control meters. Feb. 24—Time extended—Power totaliser and transmitter, total power recorder, and total power indicator. March 3—Three phase a.c. induction motor. March 10—Aerial telephone cable, d.c. interlocking relays. March 17—Oil switches, 2,200-volt. April 21—Electric overhead travelling cranes, plate bending and straightening rolls and electrical equipment, balls and ball bearings. April 28—Automatic sub-station equipment.

West. Aust. Government Tender Board.—2,000 kv.a. transformer.

GENERAL

Australian Gaslight Co., Sydney.—March 2—750 kw. turbo generating set.

Brisbane City Council.—Feb. 23—H.D. bare and V.I.R. cables, insulators, switch and fuse gear, house service fuses, indicating watt hour meters, transformers, street lighting equipment and lamps. May 13—Special track-work for tramway sheds.

City Electric Light Co. Ltd., Brisbane.—March 22—H.T. porcelain insulators; 12,500 kw. turbo alternator, two water tube boilers, etc.

Melbourne City Council.—March 8—Totally enclosed armored type switchgear. April 7—2,000 kw. rotary converter, etc., switchgear, and a.c. control panels. June 16—5,000/5,500 kw. turbo alternator.

Metropolitan Water Sewerage and Drainage Board, Sydney.—March 25.—Two steam turbo pumping units.

Sydney City Council.—Feb. 22—Power house switch-gear, steam raising plant (time extended). March 8—Power transformers, armorclad switchgear for 33,000-volt step-down sub-stations. May 3—Submarine cables.

NEW ZEALAND

Public Works Dept.—March 2—Section 190, Lake Coleridge, 33,000-volt switch and protective apparatus. Section 150, Arapuni, synchronous condenser and trans-formers. March 23—Section 125, Arapuni, 22 kv.a. switch-gear; section 154, filter presses and testing equipment. April 6—Section 133, Arapuni, storage battery, motor, generator and switchboard. April 23—Section 158, Arapuni, 11,000-volt, metering equipment and switchgear.

ELECTRICAL PUBLICITY IN ENGLAND

A recent number of the "Electrical Review" makes a feature of some of the latest developments in electrical publicity work in England. Greatly increased attention has been paid to electrical publicity of late, with very gratifying results both for purchasers and for suppliers of electrical energy and appliances. Apart from the various associations for advancing the application of electricity, particularly to domestic service, showrooms are being established by many of the electric supply authorities, acting in co-operation with the trading interests, and electrical exhibitions are becoming popular in various local centres. Several new developments have taken place along these lines during the last few months.

The Swansea corporation electricity department has opened show and demonstration rooms in an imposing building situated in a main thoroughfare of the town. The building is in itself attractive and this, coupled with the provision of a fine window display, makes a strong appeal to the public. There is a showroom for exhibition of all kinds of electrical apparatus, and a demonstration hall with accommodation for nearly 200 persons. In addition there are special exhibits such as a fully furnished dining-room electrically equipped, and an up-to-date bathroom.

The Hackney electricity undertaking also has recently opened new display premises, with showrooms, demonstration hall and model electrically equipped rooms. A further publicity department is that opened by the Poplar borough council. This also has showrooms and a demonstration hall. A particular feature of the window display of this undertaking is the equipment of one window with nine different types of lighting which are automatically switched in turn. The methods include correct and incorrect styles of window lighting and several different color effects. An illuminated indicator board informs the observer as to the style in each case. In this showroom many mechanical as well as domestic applications of electricity are featured.

Another form of publicity is by electrical exhibitions. Two of these have been held recently, at Leicester and Nottingham respectively. In each case there were numerous stands, furnished by various firms, and in addition an all-electric house was featured. The electric supply authorities and the electrical trades are recognising that it is necessary to give continuous attention to publicity matters. Even though great strides have been made, the public is still very much in need of education in the advantages to be derived from the use of electricity.

The results obtained up to the present indicate that once the message sinks home it is not very long before sales follow, and that each user of electrical appliances becomes a self-appointed advocate of domestic electrification.

Notice is hereby given that the Proprietor of Australian Patent No. 14612/23 for an invention relating to WALL PLUGS (Divided casing), is prepared to satisfy any demand and all requirements of the public respecting the said invention.

Full particulars from Messrs. The English Electric Co. of Australia Ltd., 16 Barrack Street, Sydney.

BRISBANE CITY COUNCIL

TRAMWAYS DEPARTMENT

TENDERS, closing at 12 noon on March 2, 1926, are invited for the following electrical generating plant:—

1. Two turbo-alternators, three phase, 11,000 volts, 50 cycles, 6,000 to 7,500 kw., steam pressure, 200 to 300 lb., complete with condensers, air pumps, circulating pumps, pipework, switchgear, and all auxiliaries.

(a) Delivered Brisbane, October 31, 1926.

(b) Delivered and erected on foundations provided by the Council complete and ready for working by January 1, 1927.

2. Watertube boilers, suitable for the above generating plant, with superheaters, economisers, feed pumps, coal handling plant, and all auxiliaries erected complete ready for working by January 1, 1927.

Tenders for plant capable of meeting the above general requirements will be considered, but the plant offered and delivery dates must be fully specified.

Tenders to be addressed to the Town Clerk, Brisbane, and to be suitably endorsed.

The lowest or any tender not necessarily accepted.

W. M. NELSON,
Acting General Manager.

BRISBANE CITY COUNCIL

ELECTRICITY SUPPLY DEPARTMENT

TENDERS are hereby invited for the SUPPLY AND DELIVERY of the following materials:—

Contract No. 3.—Hard Drawn Bare and V.I.R. Cables.

Contract No. 4.—Medium and Low Pressure Switch and Fuse.

Contract No. 5.—Medium and Low Pressure Switch and Fuse Gear and House Service Fuses.

Contract No. 6.—Indicating Watthour Meters.

Contract No. 7.—Prepayment Type Watthour Meters.

Contract No. 8.—Distribution and Street Lighting Transformers.

Contract No. 9.—Street Lighting Equipment and Lamps.

Specifications and Forms of Tender may be had on application to the Manager, Electricity Department, Town Hall, Brisbane. Charge of 5/- first copy, and 2/6 for each subsequent copy, will be made for each Specification.

Tenders close at 12 noon, TUESDAY, 23rd February.

Tenders to be sealed, specially endorsed, and addressed to the Town Clerk, Brisbane City Council, Town Hall, Brisbane.

Lowest or any tender not necessarily accepted.

F. W. G. ANNAND,
Town Clerk.

FOR SALE

1 Premier Gas Engine, 450 B.H.P.; 2 Mond Gas Producers, each 550 H.P. for working Producers alternatively; 2 Roots Blowers, one steam, one electrically driven. Number of spare parts. Particulars and Photos of Plant.

J. SCOLAR, Consulting Engineer.

G.P.O. Box 3221 P., SYDNEY, N.S.W.





Editorial





LOCAL GOVERNMENT TRADING

The Sydney city council is persisting in its purpose of embarking upon retail trading in electrical appliances. A scheme has been drawn up by the acting general manager of the electricity department and passed by the electric supply committee, which aims at extending the use of electrical energy both in industrial applications and in domestic service. To exploit the industrial field it is proposed that salesmen be employed to canvass factories, stores, etc., with a view to inducing the management to use electric lighting and power or to increase the amount of electrical energy already being used. The proposals for increasing the domestic demand are:—

(1) Direct canvass of householders with a view to inducing them to install electric lighting and heating, or to extend the uses of electricity in homes already using it.

(2) Sale of electricity consuming apparatus from demonstration trucks taken to consumers' homes, and from a showroom installed in the office block of the electricity department.

(3) Rendering of minor repair services free of cost to existing consumers by crews of the demonstration trucks in any district in which the trucks happen to be working.

(4) Wiring and connecting up free of cost to wall plugs, or other points already provided in a building, of electricity consuming apparatus purchased from the council.

(5) Wiring of homes on a cash or time-payment basis.

The council's avowed aims are to increase the consumption of electrical energy and to bring electrical service within the reach of all classes in the community. The objectives are praiseworthy, but unfortunately the means which the council proposes to employ in their attainment are not altogether justifiable.

The principle of trading in electrical appliances by electric supply undertakings is a fruitful source of discussion. Dealers in electrical appliances are generally opposed to such trading, but experience has proved that, when properly conducted, it may be beneficial to all concerned. This is largely due to the energetic publicity campaigns which electric supply authorities usually launch when entering the trading field. There are, however, such extensive openings for unfair competition between the electric supply authorities and the existing electrical traders, that it would appear better for the supply authorities to confine their activities to

selling electrical energy and co-operating with the traders in publicity work. This is especially true where the electric supply is in the hands of a local governing body, for competition between government and private interests is at all times undesirable.

The Electrical Employers' Association of N.S.W., which represents the electrical trading interests in Sydney, is strongly opposed to the council's scheme. It has good reason to fear loss of trade through the competition of the public authority. The council is out to sell appliances at minimum prices, and is not bound by the financial limitations of a private corporation. If losses are incurred the ratepayers will foot the bill. Certainly reductions in the prices of all electrical appliances are urgently needed, but underselling of competitors is not the right method. Members of the council allege that electrical traders make exorbitant profits, but there is strong reason to doubt this. The high cost of equipment is chiefly due to the high customs duties operating on imported articles, and the lack of opportunity for mass production in local manufacturing. The council will not improve matters by underselling, but will only inflict undue hardship on interests entitled to an adequate return on invested capital, and will ultimately bring loss upon itself.

The council's expressed objectives are good, but over all looms the shadow of the labor principle, Socialisation of Industry. Sydney is at present under the thumb of the labor party, and there is no doubt that expression of the socialistic principle is the main objective. This must be strenuously opposed. The reasons against local government trading are legion, but the greatest is the bitter fruit of experience. The danger of official bungling and mismanagement is so real that wherever government trading starts up it may be looked upon as almost certain that, ere long, some grave blunder will be committed. In the Sydney case the danger is showing itself right at the outset, for the capital suggested for launching the scheme is grossly inadequate for the magnitude of the proposed undertaking.

If the council really wishes to increase the sales of electrical energy and of appliances, and to bring the benefits of electric service within the reach of a larger circle of consumers, there are ways in which the objectives may be attained without interfering with legitimate trade or jeopardising the interests of the ratepayers. Some little time ago a scheme of co-operative publicity between the council and the electrical

traders was drawn up. There is no doubt that this would give excellent results if put into operation. If it is desired to go further the council might co-operate with the retail supply houses in devising a scheme for hire or hire-purchase of appliances by consumers. Further still, the council might co-operate with the electrical contractors in devising a scheme of house-wiring on hire or hire-purchase lines. All these things have been done with marked success in other places. The usual arrangement is for the electric supply authority to finance the scheme, guaranteeing the traders and contractors against loss.

Fortunately the matter is not yet definitely settled. The Lord Mayor has stated that a committee has been appointed to thoroughly investigate the proposals and that trade interests will have an opportunity of stating their views. It is to be hoped that these views will receive due consideration, and that the council will see the wisdom of co-operation instead of competition.

VIBRATION IN TRANSMISSION LINE CONDUCTORS

A matter of considerable interest has recently come to the fore in connection with research into the causes of failure of conductors and insulators on high tension overhead transmission lines, viz., the mechanical vibration of line conductors due to wind action. This vibration may set up stresses of considerable magnitude at the points of support, and is liable to cause failure of conductors through fatigue of the metal. Unfortunately little is generally known regarding the quantitative values of the stresses and strains which are due to conductor vibration, but this does not prevent the adoption of preventive measures against line failure from this cause.

The precautions which naturally suggest themselves are the use of devices to damp out the vibration, and the installation of stronger conductors in order to give an adequate factor of safety. With light lines, where short spans are used, vibration should not be very serious, and the latter course will usually be the better, particularly in cases where the electrical requirements demand only a light wire. As has previously been pointed out in these columns, it is advisable to make sure of having adequate mechanical strength. In the past so much attention has been paid to economy in capital expenditure that there has been a tendency to forget the necessity for building lines with a high mechanical factor of safety. Stronger construction for lightly loaded lines will certainly increase capital cost, but maintenance expenses will be reduced. It must not be forgotten,

also, that reliability and safety of life and property are of prime importance.

Where important lines carrying large amounts of power and employing very long spans are concerned, the question of mechanical strength usually receives proper attention. With these, therefore, there is no contributory reason for increasing the size of conductors, and it is logical to endeavor to prevent the vibration instead of counteracting its effects. The "Electrical World" recently published a short article, part of which is reprinted in these pages, describing how the vibration problem has been dealt with on an extensive transmission system in the United States. A simple and inexpensive device has been evolved, which appears to provide complete protection against vibratory stresses.

But it is not only the conductor which requires protection. In an interesting article published on another page a New Zealand engineer puts forward the theory that many of the failures which occur on suspension insulators in service are brought about by these same vibratory waves in the conductors. The idea is well worth following up and it would be interesting to try the effect of some line damping device, such as that just referred to, as a protection to the insulators as well as the conductors.

ELECTRICITY SUPPLY IN GREAT BRITAIN

It is now generally recognised that electricity is a vital factor in industrial development, and that the prosperity of a manufacturing nation is largely dependent upon the extent of the use of electric power in its industries. This arises from the fact that the use of mechanical power reduces production costs and gives rise to a considerable increase in the output of goods per worker. The reduced cost of the products of industry automatically opens up a wider field for their sale, while at the same time the increased productivity of each worker makes it possible to pay him better wages, thus increasing his purchasing power and again extending the market.

During the last few years Great Britain has been passing through a period of industrial depression brought about largely through the unsettling influences of the war. Unemployment is widespread and production costs are high as compared with those of certain other countries. Many remedies for the situation have been suggested, but so far no solution has been found. On one point all authorities appear to be agreed, and that is that increased production at lower cost is the urgent necessity. But the methods by which this is to be achieved have not been made clear.

It has been apparent for some little time that in the use of electrical energy Great Britain is lagging considerably behind some of her industrial competitors. In view of the influence of mechanical power in reducing production costs, it would appear that this conservatism has a good deal to do with the present unfortunate industrial position. A cursory examination shows that large sections of the industrial workers of the country are dissatisfied with their lot. Undoubtedly some of the trouble must be laid at the door of professional agitation, but at the same time it is obvious that the conditions of many workers leave much to be desired. Putting two and two together, there seems to be more than a probability that the combination of poor wages and high cost of living has its rise in the limited use of power in industry. In Great Britain the consumption of electricity per head of population per annum is about 200 kelvins. In the United States and in Canada, both industrially prosperous countries, the consumption is about 500 and 900 kelvins respectively.

The people of Great Britain, however, are coming to realise that greater use of electricity may help them, and the British government is now giving thought to the matter and proposes to take steps towards increasing the use of electricity by reducing the cost of its production. The prime minister, Mr. Stanley Baldwin, recently outlined a scheme, which is to be submitted to parliament, for the reorganisation of electricity supply. It is proposed to strengthen the powers of the present ministry of transport and electricity commissioners and to set up an executive board to administer electricity supply throughout the country. The board will be composed of practical men in close touch with the electric supply industry, and will be as free as possible from government control. Its function will be to co-ordinate the operations of all existing and future power stations, to establish interconnected transmission systems, to do away with small inefficient generating plants, and generally to promote efficiency in generation and distribution. An important work to be undertaken is that of bringing the voltages and frequencies of supply in all systems to a single standard. The board will have wide powers, including that of compelling undertakings to come into line with its schemes. It will work on commercial lines, raising its own capital, establishing generating stations where necessary and supplying energy in bulk to local undertakings. After paying interest and providing sinking funds, any surplus will be applied to the reduction of charges to the undertakings supplied.

By these means it is hoped to expedite the development of the electrical age in Great Britain, and to save a tremendous amount of money by promotion of efficiency, standardisa-

tion of supply and prevention of overlapping of effort. A conservative estimate states that in the next 15 years the consumption of electricity should rise from 200 to 500 kelvins per annum per capita. It is to be hoped that the development will be more speedy than this, so that Great Britain may be enabled to hold her own as a manufacturing nation against the competition of all comers. This proposed government control of an essential service is designed with a view to giving the country the new vitality that is apparently needed.

Notes and Personals

Mr. R. Silcock, representing the Fire Underwriters' Association of Queensland, has been re-appointed a member of the electrical workers' board.

Mr. F. W. Geohegan, engineer for Messrs. C. A. Parsons and Co., returned to Australia by the Niagara and is staying in Sydney at present.

Mr. C. S. Wright, of Melbourne, has been appointed to the technical staff of the hydro-electric branch of the New Zealand public works department.

Mr. J. H. Hindman, manager of the electricity department of the Greater Brisbane council, has been appointed a member of the electrical workers' board.

Mr. F. W. H. Wheadon, engineer and manager of the Adelaide Electric Supply Co. Ltd., returned to Adelaide by the R.M.S. Comorin after a tour of Great Britain and Europe.

Mr. G. G. Gluth has accepted appointment as general manager of Metal Manufactures Pty. Ltd., Port Kembla, N.S.W. He was formerly in charge of construction at the Ford company's works, Brisbane.

Mr. Arthur Waddell, of Coupland and Waddell, electrical contractors, Sydney, has been elected president of the Electrical Employers' Association of N.S.W. for the ensuing year. Mr. Waddell is chairman of the electrical contractors' licensing board.

Members of the Electrical Employers' Association of N.S.W. have agreed to the imposition of a levy, equal to half the amount of the annual subscription, to furnish funds to defray the cost of opposing the Sydney city council's electrical trading scheme.

Mr. J. M. Bridge, general superintendent of the Victorian electricity commission's works at Yallourn, has returned from a tour of Germany and the United States, undertaken with a view to investigating developments in brown coal mining and usage.

Mr. Arthur Mervyn Conway, engineer in charge of the Orange, N.S.W., municipal council's electricity supply undertaking, died on March 11, at the age of 38. Deceased was previously on the Sydney staff of the Australian General Electric Co. Ltd., but resigned in 1921 owing to ill-health. He leaves a widow and two children.

Mr. Cecil Dawson has been appointed lecturer in electrical engineering at University college, Auckland, N.Z. Mr. Dawson received his early education at King's college, Auckland, and attended the University college from 1915 to 1917, obtaining the associateship in electrical engineering. He enlisted for active service in 1918 and, after demobilisation, spent five years with the General Electric Co. at Witton, England.

A fire occurred recently at the Victorian electricity commission's new open cut brown coal workings at Yallourn, the coal becoming ignited on the surface from a bush fire which came close to the cut. The wooden housing of one of the steam navvies was burnt and some damage was done to the coal haulage tracks. The supply of coal from the cut was interrupted for a couple of days.

A conference of secretaries of the Australian Commonwealth Engineering Standards Association was held recently in Melbourne, with a view of affording the officers an opportunity of determining whether the present organisation is so functioning that the work of the association can be carried on with the maximum of efficiency and economy, and with a view to submitting recommendations for the further development and progress of the movement.

AUSTRALIAN COMMONWEALTH ENGINEERING STANDARDS ASSOCIATION

The progress report of the Australian Commonwealth Engineering Standards Association for the second half-year 1925 has recently been issued. It shows a steady advance in the valuable work which the association is carrying on. A wide range of subjects is under consideration and several tentative specifications have been approved and are awaiting publication. Six tentative specifications have already been issued, including two which have just come to hand dealing with "Overhead Line Wire Material for Telegraph and Telephone Purposes" and "Electrical Performance of Traction Motors."

The former specification covers hard drawn copper wire, bronze wire, copper binding and jointing wire, copper tapes and binders, bronze tapes and binders, copper jointing sleeves, bronze

jointing sleeves and tinned copper jointing sleeves. The specifications for wire include mechanical and electrical tests and give tables of dimensions and weights of different sizes of wire. The specifications for jointing material give tests and dimensions.

The specification for the performance of traction motors deals with d.c. series machines. It defines the classes of enclosure and deals with ratings, temperature rise, commutation and efficiency. Particulars are given of high voltage, performance and type tests. The information to be given on the name plate and supplied by the manufacturer is specified. There are three appendices covering a classification of insulating materials, methods of measuring temperature, and notes on the relation between tests on traction motors and their temperatures in service.

The provisions of these specifications are in substantial agreement with those of the corresponding British standard specifications. The publications are issued for a period of twelve months for the purpose of eliciting criticism and suggestions.

Amongst the subjects for which tentative specifications will shortly be issued are:—Dimensions and Resistance of Copper Wire for Electrical Machinery, Dimensions for Moulded Flat Top Insulating Bushes, Paper Insulated Lead Covered Telephone Cable, Electrical Pressures for New Systems and Installations, Slate Slabs for Electrical Purposes, and Railway Rolling Stock Material.

ELECTRICAL WORKERS' BOARD, QUEENSLAND

Meetings of the board were held on January 19 and 21 and February 16. Three members of the board were drawn by lot to retire, having completed the second year of their appointment. They are Messrs. E. S. Cornwall, R. Silcock and D. Bloomfield, representing respectively the electric supply authorities, the Fire Underwriters' Association of Queensland and the Queensland branch of the Electrical Trades Union of Australia. These members are eligible for reappointment and the necessary action has been taken to arrange for the nomination or election of members to fill the vacancies.

In the examinations, conducted in November last, success was attained by seven fitters, twelve mechanics and five linesmen. Six persons have been granted permission to sit for the next examinations, which will probably be held at the end of May, and three certificates have been granted without examination.

Suspension Insulator Failures

By R. Roberts, A.M.I.E.E.¹

Suspension insulators are used in strings of several units in series, and are usually applied on transmission lines operating at the higher voltages—generally above 50 kv. This type of insulator has several advantages. The failure of one unit in a string does not necessarily entail interruption of service, although failure of a number in the same string might do so. Defective unit insulators can be detected in various ways, and their replacement with fresh units can be carried out whilst the line is still alive. Many methods of live line inspection have been developed and used, from the original buzz-stick method to others more elaborate employing wireless valves and equipment. New experimental methods for finding and detecting faulty units are always interesting, for the buzz-stick is itself not without defects. The vital question, however, is, "What causes failure?" Information is required regarding the conditions which give rise to defects and whether they exist inside or outside the insulator.

An insulator manufacturer may report that his insulators have never failed; but, in the same breath, he mentions the small number of replacement units required in systems using his insulators. This is not contradiction, but merely an exceedingly fine perception of the shades of meaning applicable to a definition of the word "failure." The costs of the replacements may possibly be heavy, and the engineer wonders how to differentiate between good and bad makes and designs of insulators. He is uncertain whether most attention should be paid to first cost, or whether the installation of high priced insulators will be justified by a reduction in replacement charges. There is also the question of whether some types are better than others for his particular service. He may have had personal experience of two or three makes and might prefer one, but he will hear of many others, of which his experience is nil. He is not sure whether these are better than the ones he has used.

Some years ago, the chief causes of failure were supposed to reside in the quality of the porcelain itself, in the glaze, and in the cement used to join the different parts together. At that time this was probably correct, and the publicity given to the subject and the means evolved for the detection of faulty materials have resulted in great improvement to the manufacturing processes. To-day the art of porcelain preparation and firing has been developed to a fine degree, and the product of 20 years ago should not be compared with that made to-day

by the majority of manufacturers. But porous porcelain can and does still occur. Tests for its detection should be made very rigid, and any new methods that may be devised from time to time applied when possible.

Next to defects in the quality of the porcelain it was considered that the potential gradient was a quantity which might have great influence upon the life and service of suspension insulators. It was found that the potential difference between the ends of the insulator unit next to the line was, under normal conditions, between

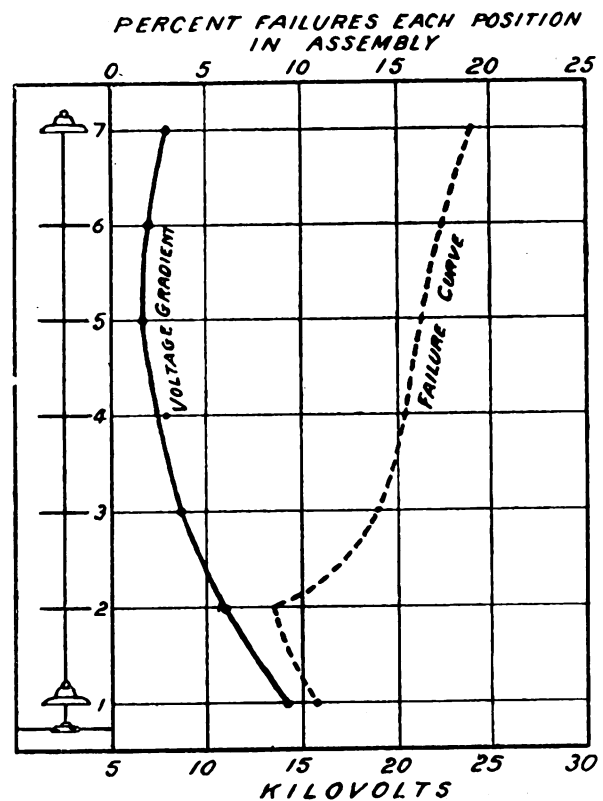


Fig. 1

30 and 40 per cent of that between line and earth for strings composed of from six to eight units. The minds of manufacturers were greatly exercised to devise means and apparatus whereby this potential gradient might be made uniform.

This is not the whole story, however, for it has been noted experimentally that at the moment of flashover, the potential gradient becomes uniform over the whole string. Each string might sooner or later be subjected to flashover potentials, and each unit in the string will, in accordance with the general practice of using flashover safety factors of 2.5 to 3, be subjected to much the same pressure as that

¹. Public Works, Dept., N.Z.

imposed upon the line unit under normal conditions.

But this does not explain failures. It is yet questionable whether the electrical stress is a determining factor in the matter, and if it is, whether it is the normal or the maximum stress. A record of replacements, taken over a comparatively long period, should give some indication whether normal or maximum electrical stress comes into the matter. Mr. H. D. Panton² has given a record of replacements over a period 1912-24. The curves for the percentage failures and the potential gradients of the insulators in service are shown side by side in Fig. 1. In some ways these results are hardly those which might have been anticipated, and they suggest

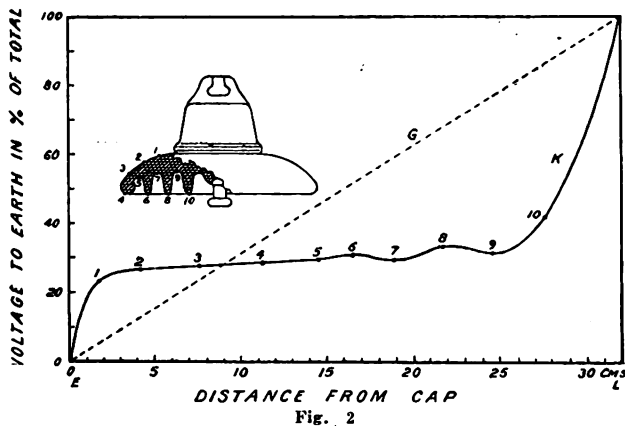


Fig. 2

that a high electrical stress per unit is not the primary cause of failure or decadence. The record does not include any but plain suspension strings; and, assuming it to be correct in every way, i.e., in the testing as well as the recording, it suggests that there is another cause of decadence and failure besides electrical stress.

Mechanical vibration might produce excessive or abnormal stresses which, in turn, assisted by the electrical stress, might conceivably produce effects which would result in failure. Mechanical surges can and do travel along a suspended wire. Meeting a suspension string, they will travel along the string to be killed or reflected by the rigid support. The reflected wave would meet the incoming wave, and could produce heavy shocks upon the insulator units. These shocks would be heavier upon the units next the crossarm than upon those nearer the line. If these mechanical vibrations or waves are detrimental to the insulators, it would be found that the upper units were most frequently replaced. That this is actually the case is shown in Fig. 1. The electrical stress might also be a cause of failure, but to a less extent. The failure curve, therefore, may be a composite curve representing mechanical stress, electrical stress, and wandering or stray stresses which

are conceivable, but difficult to name. These stray stresses might be due to electrical surges over individual units, or internal stresses in the porcelain, or they may arise from causes whose existence can only be assumed.

This particular failure curve is a record of the replacement of units found to be faulty by the buzz stick method of testing. This method has its defects. It is rough and ready, and does not show the degree or amount of defectiveness. It also suffers from defects inherent in its method of application. These might be termed personal, human, or psychological, and they depend upon the experience and health of the tester himself. The operator is always in a more or less uncomfortable position when

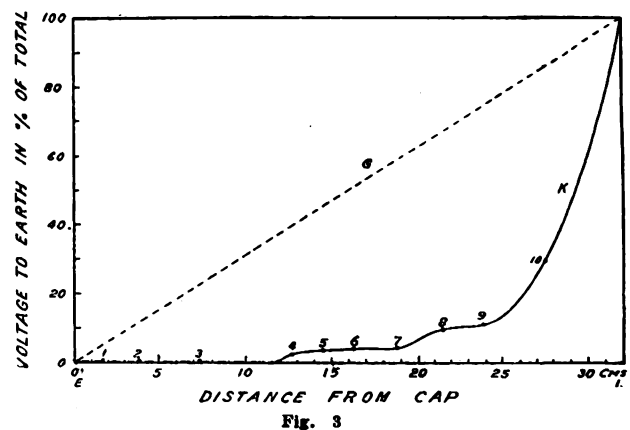


Fig. 3

making a test, and he must be consciously or subconsciously aware of the electrical dangers when doing his work. These circumstances will tend to reduce the probability that the units nearer the line (even if partially or wholly defective) will be graded defective. Thus this record of replacements may be a correct record of facts, but, from the causes stated, it should not be taken as conclusive evidence of failures. Fuller details and the knowledge of all conditions, mechanical and electrical, are absolutely necessary before it is possible to dogmatise and assert that a high potential stress is not a primary cause of failure.

A very interesting point has been brought out by Prof. Dr. Ing. Schwaiger, of Karlsruhe³. The variation in the potential differences between the ends of different units in a string shows only that various units carry different dielectric loads, but does not show where the maximum dielectric stress occurs, its amount, or the influence of rain (for example) upon the dielectric stress. The maximum surface dielectric stress per unit length of insulator surface might be considered as representing, in some measure, a figure of fatigue for that insulator.

The curve G in Fig. 2 shows the theoretically uniform potential gradient over the dry

2. A.I.E.E., May, 1925.

3. Helios Fach-Zeitschrift für Electrotechnik, June, 1924

surface of a standard type of cap and pin insulator, whilst curve K shows the actual pressure drop over the surface obtained from tests. Here the steepest gradient occurs next the pin. The curves in Fig. 3 show the gradients upon the same insulator under rain conditions, i.e., when the upper surface is wet. The potential gradient is still steepest next the pin, and the difference amounts to about 45 per cent of the whole for the last 2 cm. of surface, whereas it is only about 30 per cent for this 2 cm. when the insulator is dry.

The greatest surface potential stress in the ordinary cap and pin insulator may be seen in practice (indicated by the amount of brush discharge on a dark night) to occur always next

for the conventional type. Curve L is the probable curve of potential drop under rain conditions. The maximum gradient or surface potential drop occurs, as it did with the cap and pin insulator, next the lower connection: Here, under dry conditions, it is approximately 12 per cent, and under wet conditions a little more for the last 2 cm. of surface. This potential gradient under all conditions approximates more closely to the uniform than it does for the cap and pin insulator. Also the differences between the wet and dry characteristics are very much less marked.

Returning to the original questions it may be asked whether the characteristics and construction of this motor insulator have sufficient outstanding advantages to justify an engineer, without service experience of it, in recommending its use in face of a possible higher price. This sort of question must be faced occasionally and answered, but there remains one final consideration. Should a motor insulator fail there will be visible, not test indication of the fact, and any buzz stick or other routine testing would be entirely superfluous.

VICTORIAN ELECTRICITY COMMISSION INQUIRY

Mr. W. H. Sawyer, the American engineer appointed to inquire into the organisation and operations of the state electricity commission of Victoria, arrived in Melbourne with his assistant, Mr. H. W. Eales, on February 25. Mr. Sawyer has been appointed a royal commissioner with power to administer oaths, compel the attendance of witnesses, and call for documents. The scope of his investigations covers the existing works of power generation and distribution of the electricity commission and all projected schemes, the system of power distribution in metropolitan and country districts, the economic value of the Yallourn brown coal and the present and proposed methods of coal winning, economic aspects of the briquette manufacturing undertaking, the reasonableness of the overhead charges and operating costs in the various phases of the commission's undertakings, the commission's sources of revenue, the proposals for ultimate acquisition of the undertaking of the Melbourne Electric Supply Co., the commission's proposals for electrical publicity and the sale of electrical appliances, and the internal organisation of the commission with regard to control of staff.

The investigators have been given an independent suite of rooms in the electricity commission's building, where they will have immediate access to the Melbourne officers of the commission and to all financial and technical records. Mr. Sawyer has already commenced the inquiry, working along his own lines.

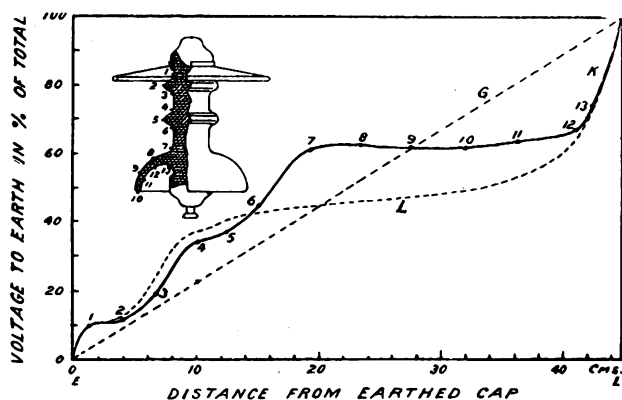


Fig. 4

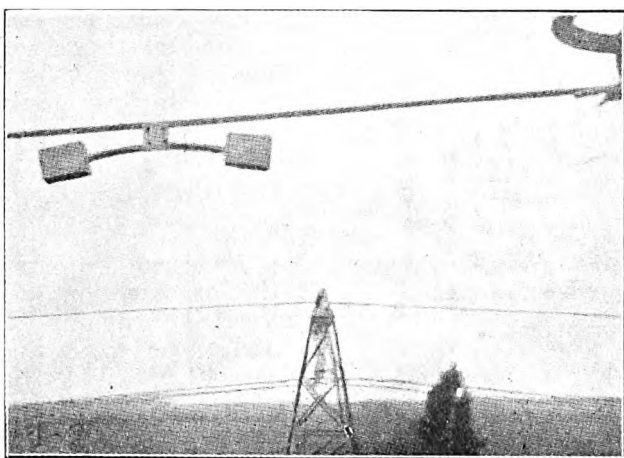
the pin. A curious but noteworthy fact is that the brush discharge is not always most brilliant on the insulator next the line, but on one string it will be on No. 1 and on another on No. 2 or No. 3. On different nights the distribution of the glow will be altered.

A type of insulator little known in Australasia, but which has a great vogue and has given good service on the Continent, is known as the "Motor" insulator. It was developed by the Motor Co., of Switzerland, an offshoot of Brown, Boveri et Cie. In some ways this design is a radical departure from the orthodox American types. It has one petticoat at the bottom, a metal shield or umbrella at the top, and caps top and bottom where metal (not cement) attachments are used. The porcelain is placed in tension, not in shear. The mechanical strength is approximately double that of its better known rivals, and it is said to be proof against thrown stones. One outstanding feature is its total immunity from puncture. Even under oil, the flashover goes through the oil in preference to the porcelain.

All the foregoing characteristics might be termed superficial and they do not in themselves suggest any immunity from fatigue. Fig. 4, however, shows the distribution of potential over this insulator, which is much better than

Overcoming Vibration in Overhead Conductors

From time to time mechanical troubles have been experienced on overhead e.h.t. transmission lines due to vibration being set up in the conductors. The Southern California Edison Co., which is erecting a new 220 kv. line, has recently given a good deal of attention to this problem in the endeavor to discover means of counteracting the ill effects of the vibration. From observation it was discovered that the principal cause of vibratory waves in the transmission conductors was wind blowing across the line. It was noted that the amplitude of the wave varied with the velocity of the wind and, under certain conditions, the wave length also varied with the wind velocity.



Vibration Damping Device attached to 220-kv. Line

It was considered that the logical way to stop the vibration was to break up the symmetry of the conductors. In order to test this theory a solid aluminium wire was wound on a conductor for a length of 100 ft. near the centre of one span. This was found to appreciably reduce both the tendency of the conductor to vibrate and the amplitude of the vibration. But the method was considered impractical and the scheme was dropped.

Next a 12-ft. length of cable of the same type as the conductor was clamped underneath the conductor with four parallel groove clamps at a point 30 ft. from the tower. This immediately stopped all short wave vibrations and reduced the long waves by about 50 per cent. It was quite apparent that the device contained a very important principle, but there was some question as to just what this principle was. In order to determine if it was the stiffening effect, the cable was replaced with $\frac{3}{4}$ -in. iron pipe and all its value was lost. It was then replaced

with equivalent distributed weights and again the result was bad.

A study of the effect of weights clamped to the conductor showed that considerable good could be accomplished by using proper sized weights at the proper location. A 10-lb. weight clamped to the cable 5 ft. from the support would reduce the length of the last half wave in the span apparently by a length of cable the weight of which was equal to the weight applied. Furthermore, it would also reduce the amplitude of the vibration in the last half wave. If the weight was increased beyond the weight of the conductor in a half wave, a new point of reflection was formed at the weight and the vibration continued undiminished in the span.

Following up this idea, sacks containing various weights of metal punchings were attached to the line at various distances from the point of support. It was found that with three 10-lb. sacks pulled up to the conductor 10 ft. apart all visible vibration on the cable stopped. By suspending the same sacks from the same points with 50 ft. of cord each, the same results were obtained. By replacing them with 10-lb. lead weights clamped to the cable in the same location, all the good effect was lost. This demonstrated that the method of attachment was the secret of the success or failure of the different weights.

Two 20-lb sacks were then tried, hanging 2 ft. from the suspension clamps at each end of a 1,000-ft. span. With these in position all vibration stopped. The same result was obtained with 10-lb. sacks 5 ft. from the clamp. It was found that less weight was needed to stop the short waves than the long ones, probably because the weight of the conductor in the short half wave was less.

With the knowledge that a certain sized weight attached to the cable with a resilient connection at each end of the span would stop all visible vibration, an improved damper was devised consisting of a piece of 660,000-c.m. steel core aluminium cable 30 in. long, which is the same size and kind of material as the main conductor, with a 7-lb. block of concrete cast on each end. This was clamped to the conductor with a parallel groove clamp, 5 ft. from the conductor support in the manner shown in the illustration. This device effectively damped out all vibration. It is planned to equip the two present 220-kv. Big Creek lines of the company as well as the new 220-kv. Vincent line with a device of similar type in order that the danger of injury to the conductors from vibration may be avoided.—(Electrical World).

The Yallourn-Melbourne High Tension Line

In the January and February numbers of this journal appeared an article describing the electrical equipment at the Yallourn power station of the Victorian electricity commission. Therein it was explained that the principal function of the station is to supply electrical energy to the city of Melbourne. A description was given of the outdoor transforming and switching apparatus, in which the voltage of the energy generated is stepped up to a pressure suitable

The input pressure to the line is 132 kv. and the receiving end pressure is maintained (by the aid of synchronous condensers) at 120 kv. There are two circuits, carried on a single line of galvanised steel towers. Each is designed for a normal loading of 27,780 kv.a., but is capable of transmitting 45,000 kv.a. if necessary. When the demand of the city has increased to a point that will require duplication of the Yallourn generating plant a second two circuit

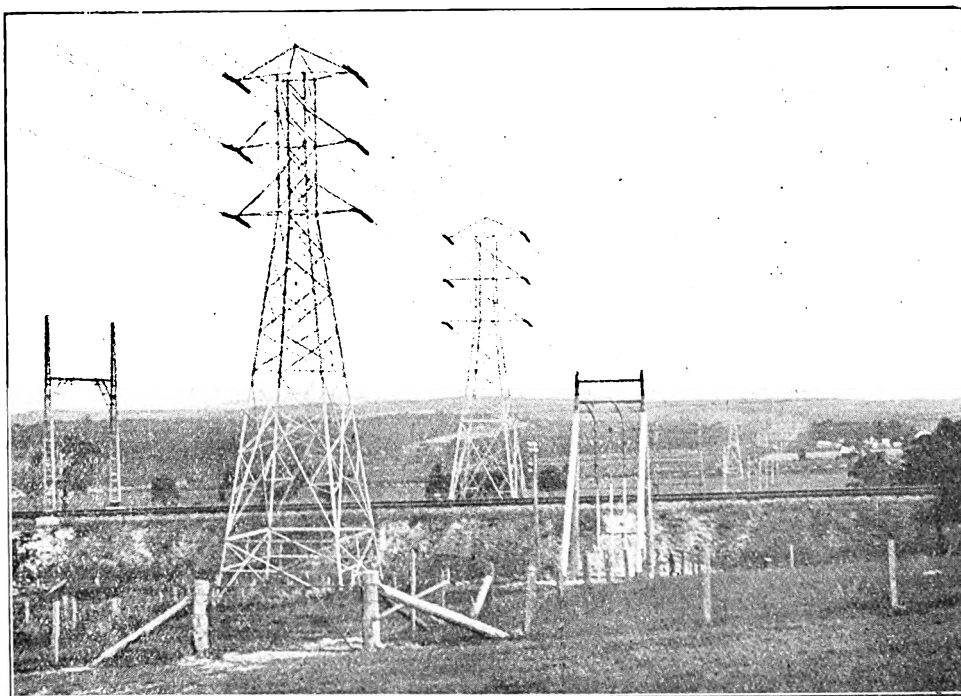


Fig. 1. Railway Crossing at Ringwood

for long-distance transmission, and brief reference was made to the high tension line which conveys the supply from Yallourn to the city.

This transmission line is 110½ miles in length. It commences at the Yallourn switchyard and runs generally in a westerly direction to a point near Dandenong, whence it makes a wide detour, passing around the northern portion of the city of Melbourne, outside the settled suburban radius, and finally turns back in a south-easterly direction to terminate at the Yarraville terminal station on the west side of the metropolitan area. The line passes through country of varying contour: in some parts flat, in others undulating, and in certain sections hilly and rough, though no ranges of any great height are encountered. The survey of the route was carried out by Messrs. J. M. and H. E. Coane, of Melbourne.

tower line will be installed. This will run parallel with the first line as far as the Dandenong district, but thence it will run direct to a new terminal station at Richmond on the eastern side of the city.

Conductors

The conductors for the present two circuits were supplied by the Aluminium Co. of America. They are of aluminium, steel reinforced, with cross sectional area of 336,400 circular mils, equivalent to 0.264 sq. in., and overall diameter of 0.741 in. They consist of 30 strands of hard-drawn aluminium arranged around a core of seven strands of high grade galvanised steel. The cable was delivered in lengths of 5,450 ft., and about 700 miles of it was used in the line. It weighs 2,788 lb. per mile, its ultimate strength is 16,200 lb. and its elastic limit 11,715 lb. The maximum load which it is assumed to have

to carry is 6,000 lb. The assumed worst conditions, which would give rise to this load, are: wind velocity 63 m.p.h. at temperature of 20 deg. F., or wind velocity of 78 m.p.h. at 60 deg. F. In addition to the line wires there is an earthing wire, run along the apexes of the supporting towers. This is a 7/.162 galvanised steel cable, with ultimate strength of 27,600 lb. and elastic limit of 17,600 lb. Under the assumed worst conditions the load on this cable is estimated at 5,760 lb.

The conductors are supported from the towers by suspension insulators supplied by the Ohio Brass Co. At each suspension point there is a single string of seven 10-in. discs, and at each

The easements in various sections of the line vary from 250 ft. to 110 ft. The maximum is where the portion of the route that will ultimately have double tower construction passes through heavily timbered country. The normal easement for the double tower right of way is 200 ft. This allows for two steel tower lines at 50 ft. centres and one wooden pole line for local services. The 110-ft. easement is along the single tower portion of the line.

Towers

The towers, of which there are 591, are built of galvanised steel members, and were supplied by Messrs. Milliken Bros., of England. There are four types, viz., suspension, semi-anchor,

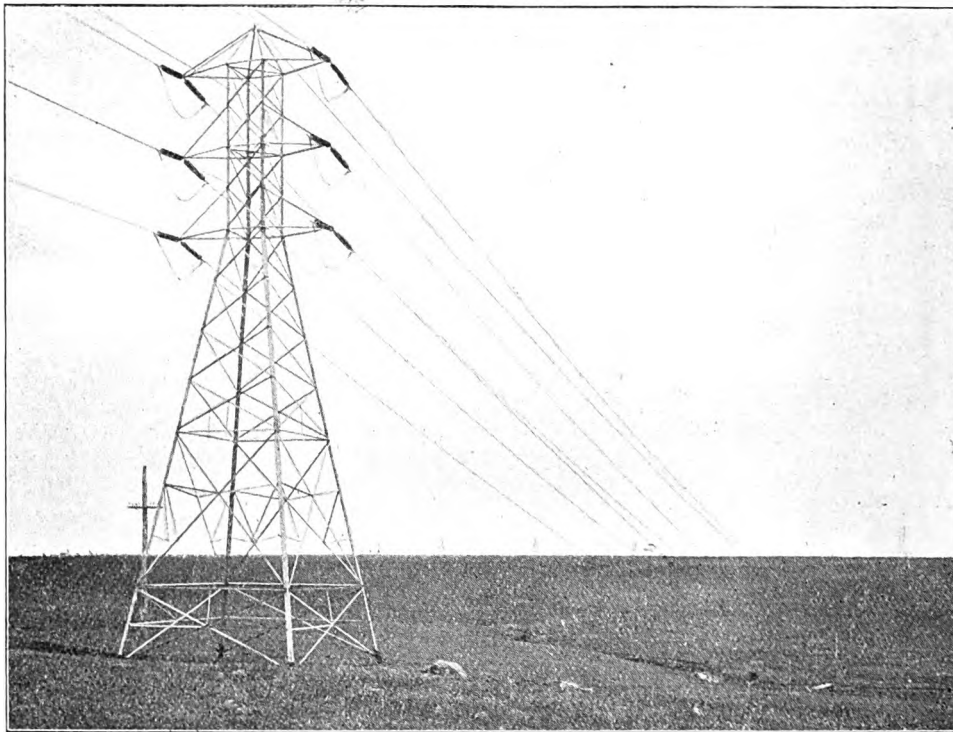


Fig. 2. Long Span (2,415 ft.) at Moonee Ponds Creek

strain point there are two strings of eight 11-in. discs. The conductor spacing is 11 ft. vertical and 21 ft. horizontal, and the standard span between towers, i.e., the span that, on the level, gives a clearance beneath the wires of 25 ft. to the ground under the worst condition, is 1,000 ft. The assumed worst condition for sag is a conductor temperature of 140 deg. F., under which the sag in a standard span is 22 ft. 9 in. The minimum spans are those at railway crossings, where a tower spacing of 125 ft. is the rule. The longest span is at the crossing of the Moonee Ponds creek valley, north of Melbourne, where the distance between towers is 2,415 ft. Fig. 1 shows the railway crossing at Ringwood and Fig. 2 the Moonee Ponds creek span.

strain and transposition. The first and second are each 79 ft. 6 in. in height and the strain towers are 76 ft. 6 in. high. The spread of base of the suspension towers is 18 ft., that of the semi-anchor towers 19 ft., and that of the strain towers 22 ft. Fig. 3 shows the principal dimensions of a suspension tower. The weights of the three types are 6,800 lb., 8,400 lb. and 15,000 lb. respectively. In some situations the height is increased by adding a 10-ft. extension to the base. In all 115 of the towers have these extensions. The heaviest tower used is the strain type with extension, which weighs 18,000 lb.

In the whole length of the line the conductors are given two complete transpositions. These are made by one-third of a turn at a time, and

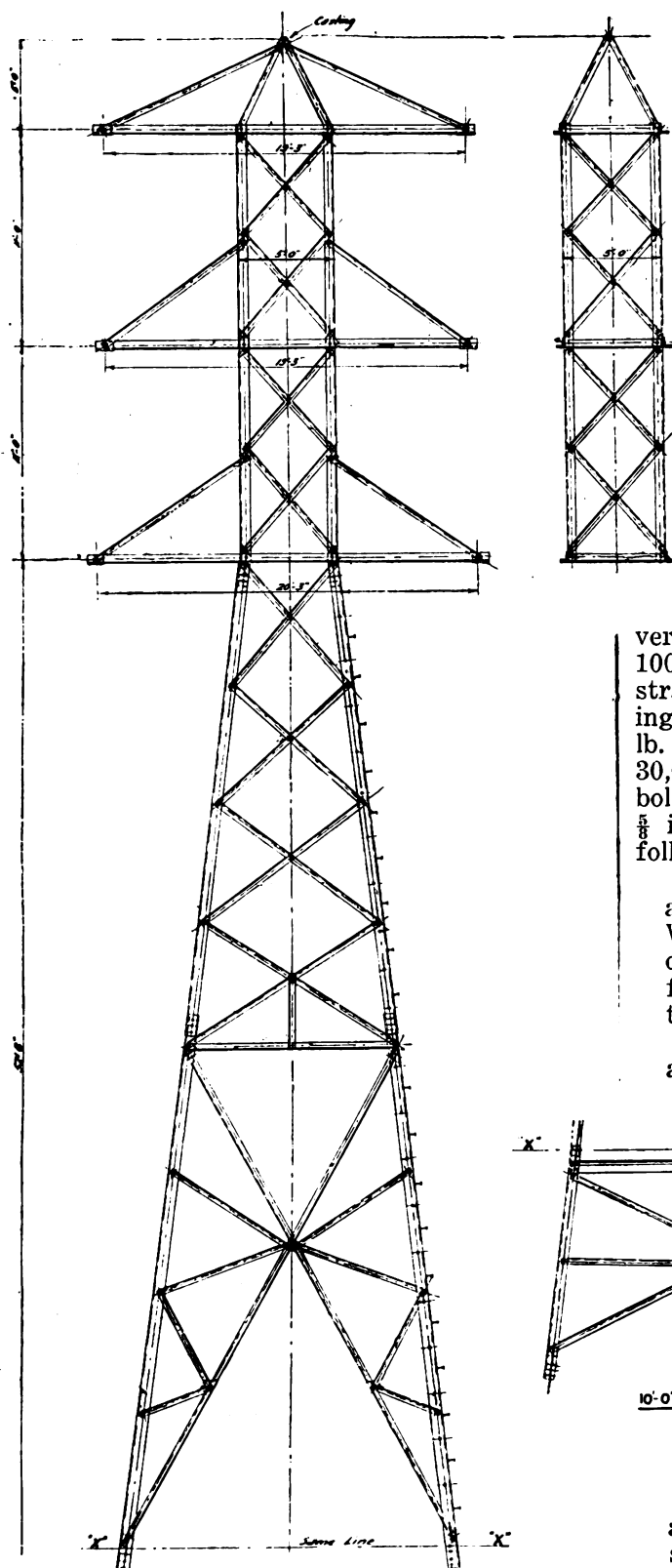


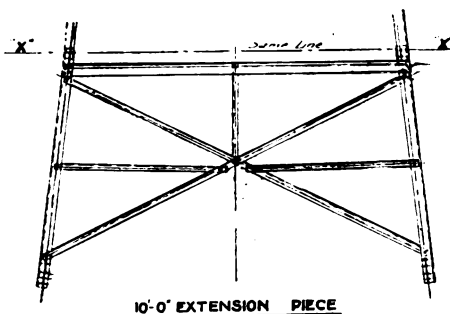
Fig. 3. Suspension Tower with Extension Piece

there are therefore five transposition towers. These are of special design so as to maintain the requisite conductor spacing. One of the transposition towers is shown in Fig. 4.

The suspension towers are designed for the following loading, without rupture or permanent distortion: transverse load due to wind pressure of 15 lb. per sq. ft. on cables of 1,000 ft. span, and 20 lb. per sq. ft. on towers, with a margin on the whole of 40 per cent; longitudinal load due to one cable broken, with a margin of 10 per cent (i.e., 6,000 lb. + 600 lb.); vertical load due to the total dead weight, with 100 per cent margin—all these loads acting simultaneously. The semi-anchor towers have to withstand transverse loading due to a 1,500 ft. span, with margin of 50 per cent; longitudinal load due to two cables, with margin of 10 per cent; and vertical deadweight load, with margin of 100 per cent, all acting simultaneously. The strain towers are designed to stand the following unit stresses: tension on net sections, 30,000 lb. per sq. in.; compression on gross sections, 30,000 — 100L/r lb. per sq. in.; load on bolts in shear or bearing, 6,000 lb. per $\frac{5}{8}$ in. bolt. These stresses allow of loading as follows:—

(a) Tower at 45 deg. angle with 1,500 ft. adjacent spans, all cables broken on one side. Wind and cable loads as before, with margins of 100 per cent for vertical load, 50 per cent for transverse wind and 25 per cent for transverse and longitudinal cable.

(b) Tower in straight run with 2,000 ft. adjacent spans, all cables broken on one side.



Wind and cable loads as before, with margins of 100 per cent for vertical load, 50 per cent for transverse wind and 33 per cent for longitudinal cable.

(c) Tower at 45 deg. angle with 1,500 ft. adjacent spans, no cables broken. Same margins as in b.

(d) Tower on straight run with 2,000 ft. adjacent spans, three cables broken on one side. Same margins as in b and c.

Erection

The towers are attached at the bases to stout angle iron stubs sunk into firm soil. In constructing the line the stubs were first put in position, accurately set to templates. The towers were then assembled in the prone position, each lined up with its stubs. The main members of the tower which were lowest with the structure in this position were attached to their respective stubs by hinges of special type, and the tower was then raised to a vertical position by the aid of a pair of sheer legs attached to the base and a haulage rope fastened to the waist of the structure. Special precautions were taken to guard against movement of the stubs due to side thrust during the preliminary stages of the lift. The sheer legs used were constructed of

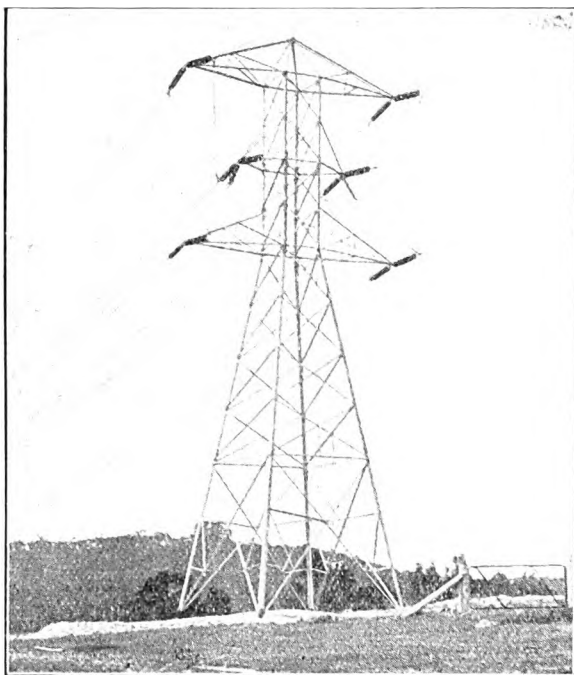


Fig. 4. Transposition Tower

4-in. galvanised pipe, in two pieces each, with a partially flexible joint. The main lifting rope was of galvanised steel $3\frac{1}{2}$ in. in circumference, with a breaking strength of over 30 tons. It passed over the apex of the sheer legs and was attached to a steel block having four 10-in. sheaves. A $1\frac{1}{2}$ -in. circumference steel rope fall passed through these sheaves and through a similar set 100 ft. distant. The second block was pinned to the ground, while the rope fall was attached either to a caterpillar tractor or to a winch mounted on a motor lorry and driven through the gear box. The tractor was used in country inaccessible to the motor lorry. As the tower was raised, either by the tractor or

by the winch, the main lifting rope rose off the apex of the sheer legs at a certain point. When the tower came near the vertical the centre of gravity passed over the hinge point and the structure was lowered gently into position by means of a back guy. The forward legs and stubs were then loosely bolted together, the main lifting rope slightly tightened to relieve the pressure on the hinges, the hinges removed and then all bolts placed in position. In many cases towers were lifted by this means in less than two minutes.

For jointing the cables a two piece compression joint was used. With this the steel core and aluminium are jointed separately, the former by means of a steel McIntyre sleeve 18 in. long, and the latter by means of a cast aluminium sleeve made in two pieces and threaded for joining at the centre. The parts of the aluminium sleeve are first slipped over the ends of the lengths of cable to be jointed. The McIntyre joint for the core is then made, and the parts of the aluminium sleeve screwed together so as to completely enclose the core joint. The ends of the sleeve are then pressed on to the cable by means of an hydraulic compressor which exerts a pressure of 100 tons. This squeezes the cast aluminium into the spaces between the strands of the cable, forming a solid mass and making a strong, neat joint.

Protection

Protection of the lines against the effects of lightning is given by the earth wire attached along the tops of the towers. At the line terminals oxide film lightning arresters are installed. Protection against overloads, faults and short-circuits is given by a parallel feeder balanced protective system, and by inverse time limit overload relays. The parallel feeder system only operates when both circuits are alive. It makes use of balanced differential instantaneous relays which operate between similar phases of the two lines. Leakage on any phase gives rise to an unbalanced current which, flowing through the relay, trips out the faulty line. When the line comes out the parallel feeder protection is cut out of circuit, so that it will not operate to trip the good line also. The inverse time limit relays give the protection necessary against equal overloading of both lines (which condition will not operate the balanced protective system). They also protect either of the lines when operating alone.

A constant inspection service is maintained on the line, patrols being stationed at approximately 20-mile intervals. Both horse and motor transport are used, and the patrolmen communicate with headquarters by means of telephones placed in huts at approximately five-mile intervals.

High Temperature Resistance Wire

Recent Developments and Present Research

By W. Wilson, M.I.E.E.*

Anyone who has been concerned in the development of heating apparatus, and also of many types of control gear involving the use of solid resistances, will have been in a position to appreciate the great improvements in the situation that have been brought about by the development of improved classes of resistance wire. It is not many years since rheostats had to depend on such materials as German silver and galvanised iron for their resistance units, with the result that the controllers and regulators of those days were cumbersome and comparatively unreliable, while the heating apparatus was even cruder. This state of things has fortunately been changed as a result of intensive research work, which is being carried out at the present time with increasing energy, to the great good of the heating and control sections of the electrical industry.

The production of nickel-chrome wire is a specially interesting phase of the development. This wire has accomplished a veritable revolution in the design of heating and cooking apparatus, and is also much employed for small resistance units, for which the great resistivity of the alloy and its ability to withstand high temperatures of the order of 700 deg. C. render it particularly suitable. If reference be made to current lists in which such information is given, it will be ascertained that wires of this composition are made in a number of different localities, and are known by trade names such as Nichrome, Brightray, Calorite and Calido. They have specific resistances ranging from 95 to 120 microhms per cm. cube, temperature coefficient of about 0.003, density of about 8.15, tensile strength of about 150,000 lb. per sq. in., coefficient of expansion of about 0.0000164 per deg. C., maximum working temperature averaging 1,000 deg. C., and melting point averaging 1,500 deg. C. The composition is, as the name suggests, an alloy of nickel and chromium; and as it is the subject of important investigations now in progress on the part of the British Non-Ferrous Research Association, the National Physical Laboratory, and a number of private research organisations, a few words regarding its present position may be of interest.

Regarding its constituents, nickel claims first attention, as all the alloys contain at least 60 per cent of this material. Practically all the supplies of the metal originate within the British Empire, most coming from Canada and New Caledonia. Thanks to recent research work, notably by the staff of the Mond Nickel Co.,

it is now possible to obtain the element commercially with a purity of 99.8 per cent. This is a powerful factor in the success of the investigations that are being made in connection with its alloys.

The function of chromium in an alloy is to increase its density, hardness, electrical resistance and resistance to oxidation. Unfortunately it is still difficult to obtain this metal free from foreign ingredients, the highest degree of purity that can be counted upon being 98 per cent. As with nickel, the best chromium is produced in Great Britain, the present process being a thermite one, involving the reduction of oxides by aluminium or silicon in a finely divided state. There is a great need, and therefore a notable opportunity, for an investigator who can produce a new process for obtaining the metal in a state of purity comparable with that of copper and nickel. The importance of pure ingredients will be realised when the effect of very small proportions of added constituents is remembered in the case of iron, the metal upon which research was first conducted in connection with the variation of its properties by means of admixture. The purer the ingredients, therefore, the more valuable and authoritative the results that will be obtained. Although chromium steel alloys have been successfully evolved with the comparatively impure chromium that is at present available, it is a fact that the impurities are such as not to affect its use for this particular purpose.

The programme of work that has been drawn up under the auspices of the Non-Ferrous Research Association is therefore to conduct the initial researches upon the plain binary alloys of nickel and chromium and to carry these out with the greatest thoroughness by employing these two metals in the highest state of purity that can be attained. Following this, the most pressing work to be undertaken is to determine the influence of the impurities. It will thus be seen that, important as the results have been to date, the work is far from reaching finality as yet, and metallurgists and engineers may shortly look forward to fresh discoveries and improved alloys, probably equalling or even exceeding in interest and in value those that have already been produced.

It was at first thought that the properties distinguishing the nickel chromium alloys, viz., the resistance to heat and to oxidation, were dependent upon the presence of a small quantity of iron, but this has been recently shown to be fallacious. Thus the plain binary alloys are

*General Electric Co., Witton, England.

the most obvious subject upon which to begin work. The routine involved in such investigations is to compound a complete series of alloys of the two metals, in which the proportion of either constituent increases or reduces in steps. The properties of the various mixtures are then ascertained, and their variation as the percentage of the significant ingredient is increased are expressed by means of curves. It has been found that the alloy containing 43 per cent nickel

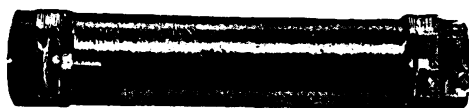


Fig. 1.

(and therefore 57 per cent chromium) has the lowest melting point, viz., 1,300 deg. C., and for this reason the range of alloys upon which special industrial research has been carried out has been confined to those possessing not more than 25 per cent of chromium. That with 20 per cent, usually known as the 80/20 alloy, has received special attention. Most of the nickel-chrome wires used for high temperature work at the present time have compositions approximating to this.

Until recently, the operation of mixing was carried out by crucible melting, which has now been definitely replaced by the electric furnace.

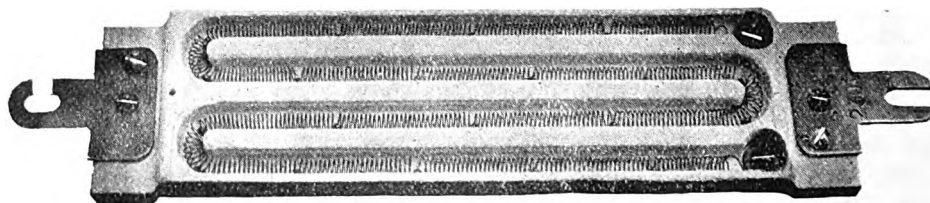


Fig. 2.

Two forms of this are especially suitable, viz., the induction pattern, and the top electrode form associated with the name of Heroult, present indications being somewhat in favor of the latter.

In addition to investigations upon the composition of the alloys, problems in connection with working require, and are receiving, considerable attention. Rolling and wire drawing are unusually difficult in the case of this material, as it is much harder than even the hardest steel rolls that are ordinarily employed. Improvements are, however, being effected. Diamond dies are at present employed for the production of wire, which can now be obtained as a commercial product down to a diameter of 0.0036 in. and even finer. Further improvements can be confidently expected from the capable workers who are engaged upon the various problems, with the result that heating and cooking appar-

atus will become even more robust and efficient. Such equipment is being manufactured and employed in rapidly increasing quantity at the present time, and the improvements that are forecasted will serve to popularise it still more.

The two illustrations show representative electrical appliances employing Brightray wire. Fig. 1 is a resistance element, consisting of No. 44 s.w.g. wire wound on a porcelain tube $1\frac{1}{2}$ in. in diameter by $5\frac{1}{2}$ in. long, the winding being covered with bakelite varnish. This wire has a diameter of only 0.0032 in., and forms a robust resistor with resistance of 5,400 ohms. The temperature rise is 100 deg. C. with continued passage of 0.065 ampere. The construction of such a high resistance in so small a bulk is a valuable achievement that is only rendered possible by the latest discoveries. The other illustration, Fig. 2, shows a heating element, suitable for an oven or radiator, composed of No. 28 (0.136 in. diam.) wire, and capable of radiating 500 watts from its overall area of only 19 sq. in.

A further problem that is engaging the attention of investigators is the increase of the "creeping" strength at high temperatures. It has been found with the older alloys that at a temperature of 600 deg. C., the tensile strength is reduced to about two tons per sq. in., above which stress the metal is subject to a progressive elongation. This trouble will doubtless

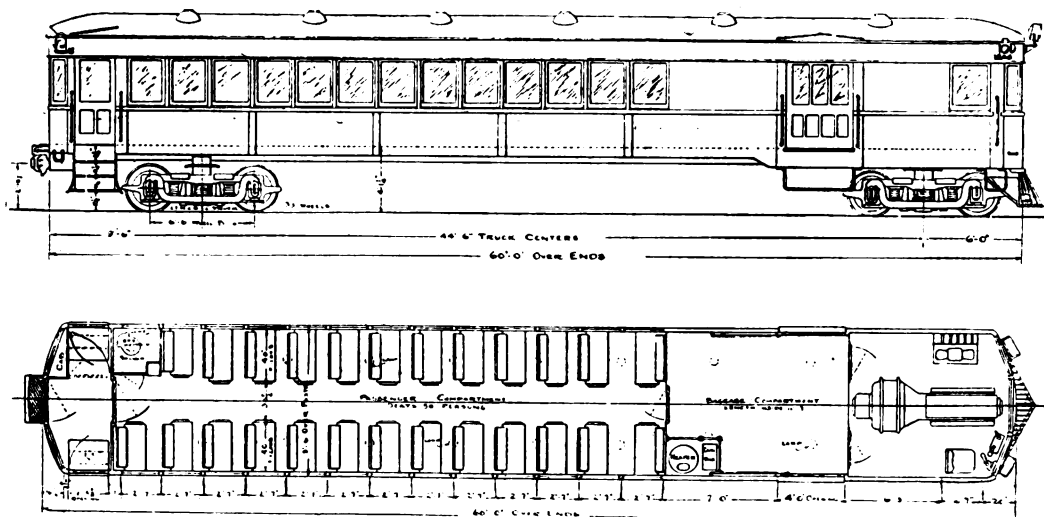
be overcome in the near future by suitable alloying or subsequent treatment, and it will then be possible to use the new material for purposes which demand a much greater tensile strength than those to which it can reliably be put to-day.

An unfortunate series of breakdowns has been occurring recently in the electric supply to the western suburbs of Sydney. The area is largely industrial and supply is given by the city council. It is stated that during the last two months an aggregate of 30 hours working time has been lost by some concerns due to the failure of the energy supply. The interruptions have been brought about by the failure of a 33,000-volt cable which supplies the district and by atmospheric conditions affecting the overhead distribution. Steps are being taken to install new apparatus in order to restore reliable supply.

Oil-Electric Railroad Cars in Service

Oil driven railroad cars have proved far more economical than steam traction in light line service, but there has always been the drawback that they could not be built for large capacities owing to mechanical difficulties in the power transmission. The advent of the oil-electric car has provided the solution of the problem, giving service intermediate between that of the light petrol car and steam or electric traction. The electric transmission of power from prime mover

Each of the smaller cars derives its motive power from a four cylinder Beardmore crude oil engine rated at 160 h.p., which is direct coupled to a B.T.H. 105-kw., 600-volt, d.c. generator. The set runs at 700 r.p.m. The generator field is supplied from a direct coupled shunt wound exciter rated at 6 kw., 60 volts. The larger cars are each driven by an eight cylinder 320 h.p. Beardmore engine, direct coupled to a 200-kw. 600-volt generator. The power is transmitted to



Petrol-Electric Car for Reading Railroad

to wheels is reliable and flexible, and experience under ordinary running conditions has proved that oil-electric cars can give reliable, speedy and economical service. This form of traction has been on trial in several parts of the world for some little time, and reports appear to indicate that it has considerable possibilities for effecting economies in railroad running expenses.

Experiments are being made with oil-electric cars on the Canadian national railways. Two types of car have been put into service, each using a crude oil engine as the prime mover. The smaller are 60 ft. long and are mounted on two four-wheel bogie trucks. They have seating accommodation for 56 passengers, and provision is made for the attachment of a trailer when desired. The larger cars are of the articulated type, consisting of two carriages with the outer ends supported on four-wheel bogies while the inner ends meet on a single four-wheel truck. The overall length of the combination is 102 ft., the weight 94 tons, and the seating accommodation 126. When present construction is completed there will be seven of the small and two of the large cars in service.

the wheels by four 100 h.p. motors mounted two each on the front and rear axles. The motor-man's controls on both cars are of the tramway type and driving positions are provided at both ends.

Under trial and in service the cars have proved very satisfactory. The larger is capable of speeds up to 50 m.p.h. and runs at a fuel consumption of about $3\frac{1}{2}$ miles per gallon of oil. The smaller is capable of similar speed, and runs at a fuel consumption of about 4.6 miles per gallon. One of these smaller cars recently did a test run from Montreal to Vancouver, a distance of 2,937 miles, at an average speed, including stops, of 41 m.p.h. The engine was not stopped during the whole of the trip.

Success in operation with petrol-electric traction is reported by the Reading Railroad Co. in U.S.A. The car which this company has had in service for some months was described briefly in the "Commonwealth Engineer," September, 1925. It is 60 ft. long and accommodates 50 passengers, and baggage. The prime mover is a 250 h.p. six cylinder petrol engine, which is

direct coupled to a 160-kw., 600-volt d.c. generator. The two motors which propel the vehicle are each rated at 140 h.p. Both are mounted on the forward bogie truck. The total weight of the car with an average load is about 45 tons.

This car provides service on a branch line 3.7

miles in length where there are four stops and grades up to 1.1 per cent. The average daily mileage is 170. On some of the trips a 49-ton coach is drawn. Since being put into service the car has travelled 16,000 miles, giving complete satisfaction.

Assisted Wiring Schemes

Electric supply authorities in many places are turning their attention to hire and hire-purchase schemes for increasing the domestic consumption of electricity. Not only are these schemes being put into operation in regard to domestic electrical appliances but to the wiring of houses. There are many communities where neither the owners nor the occupiers of houses can afford the capital outlay necessary for the installation of electric supply, even for lighting only. In such a district the electric supply authority has little chance of building up a domestic supply load unless some system of time payment for wiring and equipment be resorted to.

At the recent conference of the Electrical Development Association, in England, Mr. J. Edgar read a paper on Assisted Wiring Schemes, in which he set out the considerations influencing the adoption of such schemes and the various systems that might be used according to conditions, and described the operation of a specific system, viz., that recently put into operation at South Shields. Broadly speaking, assisted wiring schemes may be divided into two main classes, hire and hire purchase. Amongst methods which come under the former heading are:—

- (1) Additional price charged per unit through ordinary meter, accounts being rendered monthly or quarterly.
- (2) Additional price charged per unit through prepayment meter.
- (3) Fixed charge per point additional to unit charge for energy used.
- (4) Fixed charge per lamp additional to unit charge for energy used.
- (5) Fixed annual or periodical charge plus unit charge for energy used.

Under hire purchase systems are the following methods:—

- (1) Payment of cost of installation plus interest spread over a period of years.
- (2) Percentage of cost of installation paid down and the balance plus interest in instalments.

Whatever form the payments take they should be simple and easy. A quick return on the capital outlay connected with the scheme is not

necessarily essential, as in the majority of cases this would be paid out of borrowed money, the repayment of which would be spread over a period of years.

The South Shields scheme is worked under the hire system with the rental charged through a prepayment meter. It was commenced with a publicity campaign, with advertising in the local newspapers and distribution of descriptive booklets. While this was going on an agreement was arrived at between the electric supply authority and the electrical contractors regarding procedure and the prices for installation work. The supply authority also made an arrangement with the contractors whereby the latter act as canvassers for the scheme, taking application forms for connection from house to house and obtaining signatures. The forms are in the nature of agreements, one for signature by the landlord and the other to be signed by the tenant. No initial charge is made to the prospective consumer. The installations are carried out by the contractors to a standard specification, and are tested by the electric supply authority on completion.

The consumer pays for his energy and wiring installation by a penny in the slot prepayment meter, and the charge is arranged so that he pays twopence per unit in addition to the energy charge as hire for the installation. This surcharge expires when a minimum consumption of 150 units per each £1 of capital cost of the installation has been registered on the meter. The duration of the hire charge may extend up to 12 years.

The success of the scheme may be gauged from the fact that in the first six months following its inception 7,477 applications for installations were received. The service density over the supply area, i.e., the ratio of actual to potential consumers has increased from 13.8 to 50.5 per cent.

The electricity committee of the Katoomba municipal council, N.S.W., has decided to close the showroom and dispose of the electrical goods in stock. It is considered that the object of the scheme has been attained.

Recent Developments in Electrical Engineering Practice

Observations Abroad of an Electric Railway Engineer

The isolated geographical position of Australasia makes it necessary for special efforts to be sustained by the engineering services to keep in touch with the trend of modern practice in other lands. This is especially true in regard to electrical engineering, for progress has been extremely rapid, and the prosperity of the country is very largely dependent upon the use of electricity. Fortunately those concerned with the development and utilisation of power resources are alive to the necessity for maintaining constant communication with developments overseas, and channels for the absorption of fresh ideas are thus kept open. Technical journals published in Great Britain and America have a wide circulation amongst the engineers in the public services of Australia and New Zealand; locally published technical journals, which have facilities for following the latest engineering developments, are also widely read; a steady stream of books dealing with various aspects of technical practice is constantly coming into the country, and most of the engineering departments keep well-stocked libraries. But although a great deal of valuable information is gleaned from the perusal of the best technical publications, a still greater advantage is obtained by visits of engineers to countries where the most up-to-date practice has been adopted.

A trip of this nature, undertaken for the purpose of advancing technical knowledge, was recently made by Mr. H. P. Colwell, chief electrical engineer of the Victorian government railways. He visited the United States, England and Europe, studying railway electrification, power generation and electrical matters generally. A brief summary of the principal points in his observations is given in the following notes.

Power Generation

With regard to the use of pulverised coal, while the increase in the installed capacity of this type of plant must impress one, a more significant fact is that companies who, up till quite recently, have been strong advocates of the chain grate, and who have been obtaining excellent results with chain grates, have decided in connection with large new power stations to install pulverised fuel plant. In addition, several large installations have recently been made in England and Germany, after close study of the results obtained in the United States.

While by no means the last word has been said on the design of pulverising plant, and pulverised coal furnaces, there appears to be no doubt that an improvement in overall generating costs results from the installation of pulverised coal furnaces, more particularly with power

stations operating on ordinary commercial load factors. Where it is possible to operate a power station on a uniform grade of coal the difference in efficiency may be very small, but where, as is almost always the case, it is necessary or desirable to burn different grades of fuel, the pulverised coal installation has a considerable advantage. It is this feature which, in a large number of cases, has brought about a decision to adopt pulverised fuel for furnaces and, in Mr. Colwell's opinion, this factor alone justifies the use of pulverising.

Railway Electrification Systems

With respect to the choice of system for railway electrification, there is still a division of opinion as to the relative merits of the direct current and single phase systems. The recent entry into the field of the motor generator locomotive appears to offer a means of obtaining the advantages of high voltage current collection along with the desirable characteristics of the direct current motor. The operating results obtained with the locomotives which are being placed in commission on the Great Northern Cascade Division, the New York, New Haven and Hartford and the Detroit, Toledo and Iron-ton railways in the United States should be of great interest when available.

From a general survey of the position, it would appear that the total cost of converting plant which must be carried on locomotives of this type, must be greater than if this converting plant were installed in substations, and that this factor, where a large number of locomotives are in service, might easily outweigh the advantages of the single phase distribution. In addition, with the recent rapid development in the application of automatic operation and supervisory control to traction substations, one of the objections to the direct current system has, to a great extent, disappeared.

Application of Mercury Arc Rectifiers

At least one large electrical firm in America and three electrical firms in Europe are building mercury arc rectifiers for traction purposes up to large capacities. Up to date, the application of these rectifiers in America has been comparatively limited, but on one 1,500-volt electrification, viz., the Illinois Central, this apparatus is being tested out in conjunction with rotary converter plant. In England and Europe, the application has been very much more extensive, and the results obtained on the whole are satisfactory. For 1,500 volts and above, the rectifier is now generally regarded as a competitor with the rotary.

Metalclad Switchgear

A comprehensive paper on the design, construction and use of metalclad switchgear was read during last year before the Institution of Electrical Engineers by Mr. W. H. Clothier. Equipment of the metalclad type has come into considerable prominence lately, and in some quarters it is looked upon as approaching the ideal construction. The theory underlying the metalclad design is that conductors and insulators can only be given adequate protection by being completely enclosed in a continuous series of earthed metal coverings which, logically, should extend throughout the whole of the supply system. The covering not only protects the current carrying conductors but also safeguards the plant to which they are connected, and adjacent property and life. Incidentally, the use of the protective covering allows of switchgear being made much more compact than if air space was the only protection against contact, thus effecting considerable economies in building and floor space.

With metalclad switchgear all busbars, leads, connections, etc., are enclosed in metal casings with the space between conductor and casing filled with insulating compound. Arrangements are made whereby the actual switches may be withdrawn from the assembly for inspection. Plug and socket contacts are used between the switch conductors and the busbars or leads, and these take the place of isolating switches, for when a switch is withdrawn it must necessarily be dead. The switchgear is equipped with interlocks to prevent circuits being opened or closed except at the contacts of the oil switches, and safety covers are provided in order to prevent contact being made with the live metal of the socket when the switch is withdrawn.

Separate enclosure of phases is, as a general rule, only adopted where circumstances of heavy duty and comparatively high voltage occur or combine to make it advisable. Present experience indicates that multi-phase enclosure of busbars, instrument transformers and connections, sealed in compound is quite sufficient for power stations in which the aggregate full load is below 100,000 kw., or in which the pressure is below 40,000 to 50,000 volts. The practice in this respect is somewhat analogous to the respective use of three core or single core cables. The likelihood of an internal fault is remote, but should one occur the arc cannot be long or sustained, because it is confined to the earthed metal in its own close vicinity. The magnetic forces which set up mechanical stresses between conductors during the passage of heavy through fault currents, present no difficulty to the metal enclosure and compound filling. The

centres and general dimensions are compact, the conductors are short, and the compound acts as a buffer to movement under impulsive stress.

With all switchgear special attention should be paid to the insulation. Even at increased initial cost it is economical in the long run to have a large margin between normal voltage and breakdown voltage. It is essential that, in testing, the test pressure shall be well below the breakdown voltage in order to safeguard against the possibility of over-straining the insulation. The provision of sound insulation has an important bearing upon protection against the effects of lightning and other high-frequency surges. A direct lightning stroke on an overhead line will flash over the nearest insulators, but high-frequency surges come within the scope of protection. Where cables are laid in series with overhead lines excess voltage will be absorbed in the capacity of the cable, but where there are no cables a special path for discharge to earth must be provided. Good insulation is of prime importance for withstanding the effects of abnormal conditions.

SYDNEY CITY COUNCIL'S POWER PLANT

The Sydney city council has received 12 tenders for plant for the new Bunnerong power station, but 10 of these have been declared informal. The remaining two are submitted by the Australian General Electric Co. and the Cockatoo Island dockyard. The acting general manager of the electricity department has reported in favor of the former, but the electric supply committee recommends acceptance of the latter. The respective prices are £628,234 and £666,605.

Early in the morning of Wednesday, February 10, a fire occurred at Aberdeen House, 206 Clarence street, Sydney, resulting in the offices of A. Beal Pritchett (Aust.) Ltd., agents for Heemaf S.K.A. motors, and of Johnson and Phillips Ltd., the well-known cable makers, being completely gutted.

The Thames Valley power board, N.Z., is embarking upon a scheme for growing its own power poles. It is proposed to plant 10 acres per year with 680 trees per acre for 30 years. It is estimated that after the expiry of this period it will be possible to cut 3,000 poles per year. The actual cash outlay will amount to £7,250.

Electrical Employers' Association of N.S.W.

The Electrical Employers' Association of N.S.W. held its annual dinner and meeting on Feb. 25. About 100 members were present, and Mr. R. Burgin, the president, occupied the chair. In responding to the toast of "The Electrical Industry," Mr. Burgin stated that there is promise of great progress in the electrical industry. Coming every day nearer to reality is a fully electrified state with current available to every householder and manufacturer, not only for lighting but for power purposes. In order to assist the advance towards this ideal the trade must spare no effort and must make widely known the benefits of the use of electricity. Continuing, he said, "Electricity has been in use for a considerable time in the city and immediate suburbs, but during the last few years a remarkable increase has taken place in its general use throughout the entire metropolitan area and in all the principal country centres of the state. To-day almost every centre of population has an efficient electric service. These are conducted mainly by municipal, shire or county councils. The past year has seen also the completion of the metropolitan network of electric supply mains, so that the entire area of approximately 400 sq. miles is now reticulated for industrial and household service. In the country, the number of town electric supply schemes has more than doubled during the past four years, while at the present moment, there are in course of development several hydro schemes to provide electrical service for a large portion of the rural population. It is gratifying to note that the government has recently endorsed and promised the necessary support to bring to finality some of the principal state hydroelectric schemes introduced during the previous administration.

"Whilst the responsibility of inaugurating these schemes has been accepted by the various public authorities, an equally important service has been rendered by private enterprise. Electrical suppliers and contractors, members of this association, have provided equipment for the thousands of existing consumers using electricity for purposes of electric lighting, heating, cooking, and motive power. To these traders must be given the credit for taking care, in an efficient and comprehensive way, of this important phase of electrical development. Such a service to the community has only been built up after the expenditure of an enormous amount of money, energy and time and the investment of much capital. It is only proper, therefore, that the trade should be prepared, if necessary, to fight for the maintenance of these rights of private enterprise.

"Throughout the history of electrical development a very definite line of demarcation has been drawn, distinguishing the province of public authorities and private enterprise and any attempt to encroach upon the legitimate field of private traders without just cause or definite evidence of their default, cannot be justified. It is therefore sincerely hoped that no serious attempt will be made to interfere with the co-operation which has existed for so long between all sections of the industry and which has been the means of providing as rapid and as favorable progress in the electrical field as can be reported from any other part of the Empire similarly circumstanced. Much effort has in recent years been expended in formulating a comprehensive co-operative scheme for further developing and stimulating the use of electricity, which, as soon as it is put into operation, will no doubt meet with the same success as similar schemes now in operation in other countries.

"The one fly in the ointment of our outlook just now is the dispute which we have with the Sydney city council over municipal trading in electrical appliances. I do not propose to go into details about it at the moment. I am not sure whether our smaller members realise how deeply this move is likely to affect them and how many are likely to go to the wall through it, so I ask that you all go into the matter and try to grasp the fact that the city council method of trade is unlikely to be of benefit to us, but will ruin a good number who are struggling for a footing in the suburban area. If you will do this, all of you who have been inactive will take an interest in the fight which we have been waging. We want every member who is interested in this fight, not only for our rights but for the rights of consumers, to share the responsibility of it."

The annual report for the year ended Dec. 31, 1925, points out that during the year electrical business in the state was not as prosperous as it might have been, largely owing to the reduced activity in building operations in the metropolitan area and surrounding districts as compared to 1924. The association is very disappointed at the failure of the present government to gazette the regulations of the electrical contractors' licensing board, which was formed just at the close of the last year. This means that urgently needed reforms in regard to the carrying out of electrical installations have been indefinitely delayed, although the organisation for the licensing of contractors and the proper supervision of electrical installation work is quite ready to function.

Proposals for the formation of an electrical development association for undertaking extensive publicity work with a view to popularising the use of electricity, have been held up owing to the action of the Sydney city council. The council had agreed to assist in financing the association, but it is now considering embarking upon retail trading activities in competition with the existing electrical traders.

The radio section of the association has formed a radio broadcast bureau for the purpose of stimulating popular interest in radio. A salaried director has been appointed to carry on the work

and the radio trading interests are being benefitted by this activity.

In conjunction with its annual report, the association has circulated amongst members a bulletin setting out the history of the present unfortunate dispute with the Sydney city council, and itemising some of the strong reasons against municipal trading in electrical appliances.

The executive officers of the association for the ensuing year are as follows:—President, Mr. A. Waddell; vice-presidents, Messrs. E. Hirst and R. P. Godfrey; hon. treasurer, Mr. J. N. Parry; committee, Messrs. A. E. Kaleski, P. L. Boswell, S. Mellor, J. R. Greenwood and W. G. Watson; secretary, Mr. N. Phelps-Richards.

Electrical Progress in Great Britain During 1925

By D. N. Dunlop*

The past year, as far as the electrical industry is concerned, has been characterised by a certain degree of inertia in the home market with a steady increase in the demand for electrical machinery from overseas markets. As regards the home industrial demand for electrical machinery, the record of 1925 is one of almost unrelieved gloom. With the exception of special branches of the textile industry concerned with the spinning and weaving of artificial silk, of small sections of the metal industry devoted to the manufacture of specialities (the making of automobile and cycle accessories, for example), of certain industries which are sufficiently strong to withstand foreign competition—chemicals, rubber works, cement works and tube making—the industrial situation in Britain in 1925 was almost as bad as in 1922. Iron and steel, coal mining, cotton and wool textiles, heavy mechanical engineering were working on a bare schedule, unable to earn sufficient profits to justify plant renewals and extensions; the demand for industrial motors was confined almost wholly to replacements and the provision of new generating plant for colliery or iron and steel power stations was even less than in 1922. Whether the policy of waiting for more favorable trade conditions before modernising and extending ranges and methods of manufacture is justified or not, is a difficult question and the electrical industry has certainly been adversely affected.

The reason for this depression is to be found in the extraordinary persistence with which home needs were met by imports when the national production was more than ample to cover those needs. This applies specially to manufactured goods. The first four months of

1925 showed an orgy of imports quite beyond record in the history of the country, and those imports were not absorbed at once into national consumption.

The electrical industry has suffered severely through the decline in the national productive activity but in the foreign market it can point to a year of very considerable success indeed. The year 1925 represented a year of record activity in the export branches of electrical industry—due possibly to the effects of the first world power conference (which was, at bottom, a magnificent advertisement for the British electrical industry), but more probably to the reputation the British product has created for itself. Results are always the decisive factor, and the results achieved in power stations equipped by British firms during the last six years have been such as to discount questions even of price. In addition to this, economic recovery has been fairly rapid in certain markets which were badly depressed a year ago. Japan placed some important orders with British firms in 1925 and there is little doubt that, in a few years, Great Britain will be challenging the American domination in that valuable market.

South Africa is embarking on suburban and main line electrification on a large scale and provided British firms with important contracts; India is in a sounder position financially than it has been at any time during the last four years and absorbs an increasing volume of electrical products every year, although Swedish and German competition threatens again to become acute; New Zealand has found its plans for ensuring an adequate national supply of electricity inadequate to meet the extraordinary demand that has arisen for electrical power and is now contemplating further electrical

*Director, the British Electrical and Allied Manufacturers' Association.

schemes; Australia is driving steadily ahead, both industrially and agriculturally. All those countries increased their plant requirements during 1925 while, in addition to them, other markets opened out, especially in the South American and Central American zones, in Central Africa, in the middle east and in the Straits Settlements. The electrical industry was never in a stronger competitive position than at the present moment and is preparing for more intensive cultivation of the export markets than even now. It is steadily advancing against American, German and Swedish competition and gaining ground wholly on a basis of results.

In the electric supply industry considerable improvement is recorded. The power stations built since the conclusion of the war, Dalmarnock, Barton, North Tees, Nethells, Agcroft, have reached thermal efficiencies as high as the most optimistic engineer would have thought possible in 1917, and there are now over 30 stations in Britain which, with an average thermal efficiency of 16 per cent, can stand comparison with similar stations in any other country. The achievement of the last five years has established the British electrical tradition and this factor

will play an increasingly important part in the future. There are even now signs that large electrical schemes will be initiated in Britain; the new Bristol station on the Severn estuary destined to house 250,000 kw., the extensions to Barking station of over 100,000 kw., the new stations at Oldham, Stockport, and in the south-west midlands, the important developments taking place in West Lancashire and the West Riding all point to the fact that a further expansion in electrical power production is at hand.

The year 1926 should be fairly satisfactory from the electrical point of view. The educative campaign carried out during the last two years in the daily press, directly and indirectly, has brought home to the nation as a whole the necessity for greater electrical development and there is a widespread interest in electrification. The industrial situation is beginning to clear up, largely as a result of greater stability in international politics, and the realisation of a national electrical policy by the government will do much to place at the disposal of industry that which it requires above all in its struggle against foreign competition—an abundant and continuous supply of cheap electrical power.

Publicity by New Zealand Power Boards

The development of electricity supply, particularly for domestic purposes and in rural service, is proceeding very rapidly in New Zealand. The Dominion is blessed with magnificent power resources and has the advantage of a far-sighted national policy for their development. Local administrative bodies are co-operating with the national government in spreading the benefits of electrification and, in addition to the technical work involved in laying out systems for the distribution of energy, are doing valuable service by educating the public in the advantages to be derived from the use of that energy. Thus the demand is being stimulated and the development made more rapid, to the benefit of all concerned.

An example of the publicity work being undertaken is given by a booklet published by the Waitiki power board which was constituted in 1923 and gives supply in the borough of Oamaru and the northern portion of the province of Otago. This booklet explains the uses of electricity, the methods and conditions of supply, and the need for free and general acceptance of the facilities available in order to allow of extensive power distribution schemes becoming self-supporting. In addition information is given about the board's undertaking, and the tariffs

for lighting and power supply are scheduled. At present the board is supplying portion of its area with energy generated in the power station taken over from the Oamaru borough council. When the present extensions to plant at the Lake Coleridge hydroelectric station of the public works department are complete, bulk supply will be taken from this source and the board will be able to put its full scheme into operation. Capital for the establishment of the undertaking is being provided by a loan of £135,000. It is interesting to note that, in order that all may be able to partake of the advantages of electricity supply, the board is prepared to give financial assistance to prospective consumers to enable them to pay for their installations and equipment. Thus the board not only advertises the benefits of electrification but gives practical help to those who wish to obtain those benefits.

Methods such as these are being practised all over the country, resulting in marked benefit to the people as individuals and as a nation.

It has been stated that buses operated by the Adelaide municipal tramways trust are being run at a loss which in some instances is as high as 5d. or 6d. per mile.

ELECTRICITY SUPPLY IN THE UNITED STATES DURING 1925

According to the "Electrical World" the electrical energy generated by central stations in the United States during 1925 totalled 59,517,000,000 kelvins. Of this amount, 21,570,000,000 kelvins were generated in hydroelectric plants and the remainder in stations burning coal, oil or natural gas. The total generator rating was 26,830,000 kv.a. The consumption of coal was approximately 35,488,800 tons, of crude oil approximately 9,869,000 barrels, and of natural gas about 47,313,400,000 c. ft. The distribution of energy sold was approximately as follows:—Lighting, 13,670,000,000 kelvins; power 27,867,000,000 kelvins; railways, 6,460,000,000 kelvins. The total number of customers of all kinds is estimated at 17,937,160, and 63,100,000 persons, or 54.4 per cent of the population, live in electrically lighted houses. It is estimated that industry is 65 per cent electrified, including electrification from private generating plants. The gross revenue from sales of energy throughout the country totalled £294,000,000, and the total operating expenses amounted to £131,800,000. The increase in units generated over those for the previous year was about 9.5 per cent, and the increase in revenue was 8.8 per cent.

COMPARISON OF ELECTRICAL DEVELOPMENTS

The "Electrical World" recently published an interesting table of statistics showing the extent of electrical developments in the principal countries of the world in 1924. The information includes the population of the various countries, the number of people living in electrically lighted abodes, the number of central stations, the total generator rating, the distribution of energy for different purposes, and the total quantity of energy generated in central stations during the year, not including the energy from private industrial plants. The data was obtained through the co-operation of the United States embassies in the different countries but, owing to the difficulty of collecting statistics in some cases, it is not quite complete. Nevertheless, the tables afford material for some very interesting comparisons.

In order to arrive at figures that would give at a glance an idea of the relative use of electricity in the principal countries of the world, the following table has been worked out from the statistics in the "Electrical World." In some instances the figures for the number of units generated per capita are only estimates,

but in general the table may be taken as a fairly accurate index of conditions in 1924. In studying it, however, the fact must be borne in mind that developments in some countries have been extremely rapid since that year. For instance, the number of units generated per head of population in New Zealand are set down at 145, but in June, 1925, this had risen to 214.

Comparative Statistics of Electrical Development
Year, 1924.

Country	Energy generated per head of population, kilowatt-hours per annum.	Percentage of population living in electrically lighted homes.
Canada	878	43
Switzerland	505	92
United States	484	52
Sweden	390	42
Norway	350*	67
Australia	237	36
Belgium	216	34
Argentina and Paraguay ..	177	—
Chile	169	—
France	150	65
New Zealand	145	67
Great Britain	145	17
Germany	140*	15
Italy	135	12
Japan	100	54
Netherlands	67	32
Cuba	62	19
Spain	60*	80
Denmark	59	74
Portugal	55*	7
Hungary	43	—
Finland	35	9
Estonia	30	23
Czechoslovakia	27	52
Newfoundland	27	19
Uruguay	27	—
Peru	21	10
Brazil	19	7
Mexico	18	2
Latvia	12	23
Equador	12	—
Bolivia	11	—
Bulgaria	10	6
Venezuela	10	—
Guianas	10	—
Poland	7	13
Greece	6	27

*Estimated; cannot be taken as accurate.

It is interesting to note that Australia is placed sixth in the tabulation, following immediately after the countries noted for their extensive development of hydroelectric resources. But though this country is close in numerical order it is a long way behind the first five in actual consumption of electricity, and only holds its place by virtue of the fact that developments in the remaining countries are so poor. New Zealand, of course, must not be included as poorly developed electrically, for it is even now outstripping Australia, and is rising to take its place beside the countries which benefit from the use of ample water powers.

Melbourne Electric Supply Co.

The Melbourne Electric Supply Co. Ltd., which supplies electrical energy in the cities of Melbourne and Geelong, has recently issued its balance sheet and annual report on the operations of both undertakings. The balance was taken on Nov. 12, 1925, instead of at Aug. 31, so that the period covered is 14 $\frac{2}{5}$ months. The alteration in the date of balancing was made because the first compulsory purchase rights under the company's original franchise accrued to the authorities on Nov. 12, and as it was necessary under the conditions of the Melbourne Electric Supply Company Act, 1924, to balance at that date, the one balance was deemed to be sufficient.

The profit and loss account shows that the balance brought forward from the trading account amounted to £567,611, as compared with £414,071 for the previous 12 months only. After providing for debenture and gold bond interest and for the respective sinking and service funds a balance is left of £425,723. To this is added a sum of £23,337 brought forward from the previous year. From the total amount dividends have absorbed £80,030, and transfers to general and sundry reserves amount to £304,988. In addition the final dividend for the 12 months ended Aug. 31, 1925, absorbed £40,030. Thus a balance is left of £24,012. The directors recommend that this be applied in paying further dividends on March 1 and June 1, 1926.

During the period under review the company's business has continued to expand. The total area supplied by the two undertakings is about 116 sq. miles, with population of 530,000. Supply is given in 1,074 miles of streets, this being an increase of over 45 miles during the period. Several of the company's bulk supply agreements have expired lately and the services to the districts concerned have been taken over by the state electricity commission. In the Melbourne area the company purchases a large portion of its energy requirements in bulk from the state electricity commission, and the supply thus purchased has now reached 75 per cent of the total energy required for distribution. In consequence the proportion supplied by the company's steam power house at Richmond is rapidly diminishing and it is probably only a matter of about a year until the whole of the supply required by the company will be purchased from the commission.

In the Geelong undertaking the reconstruction initiated some years ago has now been entirely completed and the new plant is operating well. From this power station the company sells bulk supply of energy to the electricity commission for distribution in the south-western districts of the state.

This balance sheet is the last which will be issued under the statutory conditions which have hitherto obtained. Operations on and after Nov. 13 last have been and will continue to be carried on under the provisions of the new act of parliament which embodies an agreement for an extension of the company's franchise under certain limitations. The government has options for purchase of the Melbourne and Geelong undertakings in 1930, 1933 or 1935, and the company has the option of demanding that purchase shall take place on Aug. 31, 1930, if so desired. The exact figure of the purchase price has not yet been determined.

During the last few years the company has accumulated reserves, a large portion of which will be required for the purpose of meeting the depreciation clauses of the purchase agreement, but still leaving a remainder for investment. These are not physical assets, for acquirement by the government, but remain the property of the shareholders. The administration of these funds, therefore, has been placed with a new organisation, Melbourne Investment Trust Pty. Ltd., the shares of which are held solely by Melbourne Electric Supply Co. Ltd. This organisation will deal with the investment of funds quite independently of the electric supply organisation.

The expansion of the company's business in both undertakings during the last year is shown by the following statistics:—

Melbourne Undertaking

Year ended Aug. 31—	1924	1925
Kelvins sold	87,800,000	96,900,000
No. of consumers	92,649	101,360
Lighting, etc., kw.	93,800	109,780
Motor connections, h.p.	66,900	76,800
Total connections, kw.	163,700	186,580

Geelong Undertaking

Year ended Aug. 31—	1924	1925
Kelvins sold	11,394,000	14,300,000
No. of consumers	6,431	7,045
Lighting, etc., kw.	6,530	7,570
Motor connections, h.p.	7,600	9,300
Total connections, kw.	14,130	16,870

The managing director of the company is Mr. F. W. Clements, M.Inst.C.E., M.I.E.E. Mr. A. L. Hargrave is mains engineer of the Melbourne undertaking, and Mr. G. G. Jobbins is engineer and manager of the Geelong undertaking.

A young motor mechanic met his death recently at Hobart through coming in contact with a faulty switch in a workshop. It was stated at the inquest that the switches were altered after the accident with the object of hiding their defects from inspection.

SUCCESSFUL RURAL SUPPLY IN NEW ZEALAND

The Thames Valley power board is one of the most successful of the electric supply authorities operating in New Zealand. It was formed in 1920 and now distributes electricity in an area of over 2,000 sq. miles, including extensive rural districts and several important boroughs. The population of the area is about 30,000. The energy is purchased in bulk from the public works department, being generated at the government hydroelectric station at Horahora. The present demand is about ten million kelvins per annum. A large amount of power is used for driving milking machines, and out of 1,600 motors in the board's area no less than 1,400 are of 2 h.p. capacity for milking service. This load results in the peak demands coming on at 7.30 a.m. and 5.0 p.m. In addition to the connections for milking machines and the extensive lighting service in the country districts there are 650 water heaters and 85 stoves installed in farm houses. This gives some indication of the manner in which the farm load has been developed. It is also significant that there are 1,250 miles of power lines throughout the area.

The development of the undertaking has been financed by loan funds totalling £650,000 to date. In all probability arrangements will be made shortly for raising further sums totalling £200,000. The revenue of the board has risen from £27,057 in 1922 to £99,107 in 1925.

ROCKHAMPTON CITY ELECTRIC SUPPLY

The city council of Rockhampton, Queensland, inaugurated its electric supply undertaking in August, 1924. The generating plant consists of two 750 kw. steam turbo-alternators, and the energy is distributed at 415/240 volts, 50 cycle, three phase a.c. The engineer and manager, Mr. H. Kingdon Rowe, A.M.I.E.Aust., has recently presented to the council his second annual report on the operations of the undertaking, covering the year ended Dec. 31, 1925. It will be seen that this is the first report dealing with a complete year's operations.

The amount of energy generated during the year was 1,382,120 kelvins and the maximum demand was 730 kw. The gross revenue totalled £15,026 and the working expenses amounted to £11,820. Interest absorbed a further sum of £5,892, leaving a net loss of £2,686. In considering this result it must be remembered that the undertaking is not yet developed up to its full capacity. The engineer and manager is of opinion that at the end of the year 1926 a small net profit will be shown, as there is every

prospect of increased sales of energy. A considerable quantity of power will be required for pumping in connection with the new city water supply scheme, and there are still several streets to be reticulated for domestic supply in the city area.

Works carried out during the year include the erection of 20.2 miles of l.t. mains and 3.3 miles of h.t. feeders. The capital expenditure on these amounted to £13,130. In addition 70 additional street lamps were erected. The total capital expenditure during the year was £23,697, and the total on the whole undertaking up to date is £109,199.

Statistics of the operations of the undertaking during the year are as follow:—

Kelvins generated	1,382,120
Kelvins sold—	
Lighting	291,630
Power	565,591
Street lighting	85,900
Connected load—	
Lighting, kw.	970
Domestic power, kw.	139
Motors, h.p.	1,013
Maximum demand, kw.	730
Number of consumers	1,256
Gross revenue	£15,026
Generating costs	8,295
Distribution costs	530
Management	1,345
Sundry expenses	1,150
Interest	5,892
Net loss	2,686

PERTH CITY ELECTRICITY SUPPLY

The electricity and gas supplies in Perth, W.A., are in the hands of the city council. Electrical energy is purchased in bulk at 6,000 volts from the government power station at East Perth, and is distributed at 440/250 volts, 40 cycle three phase a.c. During the year ended Sept. 30, 1925, a steady expansion was made in the electrical services. Eleven additional distribution transformers, with total capacity of 460 kw., were installed, bringing the aggregate transformer capacity up to 12,703 kv.a. Extensions to h.t. mains totalled 6.34 miles and to l.t. mains 8.41 miles. The total length of pole lines is now 265 miles. These additions to plant made supply available to 1,834 further consumers, bringing the total number of connections up to 22,653. During the period 66 additional street lamps were installed throughout the city. There are now 3,303 lamps in use. Statistics of the operations during the year are as follow:—

Units purchased	22,361,370
Units sold	20,643,970
Maximum demand, kw.	6,351
Gross revenue	£184,353
Working expenses	115,642
Interest and sinking fund	30,107
Depreciation	14,615
Bad debts	263
Net profit	23,726

During the year Mr. T. M. Carey, who had been electrical engineer of the undertaking since 1915, resigned. His place was taken by Mr. F. C. Edmondson, who had been assistant electrical engineer. Mr. C. E. Crocker is general manager of the electricity and gas department.

TRAMWAY EXTENSIONS IN PERTH

A report has recently been submitted to the Western Australian government, which operates the Perth tramway undertaking, by a tramway advisory board appointed to inquire into the whole question of tramway services and the advisability of making extensions. The board recommends several extensions of routes, involving an estimated expenditure of £117,846. For the new services 14 new bogie cars will be required, at a total cost of £38,000, also additional feeder cables costing £5,500.

In regard to the competition of bus traffic the board is of the opinion that before any tramway extension is authorised, it should be made a condition that bus service in the area to be served should be eliminated so soon as the tram service commences. To protect any investment that may be made in extensions or new lines, the board considers that there should be means provided by legislation to prevent, if necessary, the private exploitation of any zone opened up and served by state transport. Experience shows that there is not sufficient volume of business for two competitive organisations to exist in city and suburban areas, without one existing on what should be the legitimate earnings of the other.

It is suggested that bus services should be inaugurated by the tramway department to feed the trams from districts beyond the termini where the volume of traffic does not warrant tramway extensions.

BRISBANE ELECTRICITY SUPPLY

The supply of electricity in the city of Brisbane is under dual control. In certain portions, including the centre of the city, energy is retailed by the City Electric Light Co., while in several suburbs the retail supply is in the hands of the Greater Brisbane council. The council purchases its energy in bulk from the City Electric Light Co. There has been recently a good deal of discussion between the company and the council, the council wishing to purchase the company's undertaking, provided the price is right, and the company wishing to continue to supply the council with energy in bulk. The council, however, is not satisfied with the propositions put forward by the company, and is taking steps to establish a power station of its own. Tenders have been called for two turbo-

alternators of 6,000 to 7,500 kw. capacity and for water tube boilers capable of supplying steam for same, the whole of the plant to be erected and in working order by Jan. 1, 1927. It is evidently the council's intention to generate its own energy for supplying the areas it controls at present, and to take over the retailing of energy in other areas as the franchises held by the City Electric Light Co. expire. Two of these franchises expire in 1927 and 1928 respectively, but others will run for some considerable time, the last expiring in 1945.

The matter, however, is not yet definitely settled, for since the tenders were called the council and the company have had another conference and there appears a likelihood of a basis for purchase of the company's undertaking being arranged.

COLLIE POWER SCHEME, W.A.

A strong movement is on foot aiming at the establishment of a power station on the Collie coalfield in the south-western district of Western Australia. It is considered that a demand for power sufficient to justify the expenditure would speedily be developed if such a station were laid down. Supply would be made available to the town of Collie and the port of Bunbury, to the coal mines in the area and to such other industries as might be established. It is stated that fertiliser works and a large refrigerating plant are to be laid down in the district and that these will require considerable quantities of electrical energy. It has been estimated that the demand of the district for the first two years would be about 4,087,400 kilowatt hours per annum, increasing later to 8,000,000 kilowatt hours. The estimated capital expenditure would be £216,650, and the cost of producing energy would be 1.759d. per kilowatt hour for the smaller demand and .92d. per kilowatt hour for the larger. By far the largest demand would be that from the coal mines.

The state government is favorable to the proposal and has expressed its willingness to assist the local authorities in the undertaking. A public meeting was held recently at Collie and, as a result, certain concrete propositions are now being placed before the government. It is suggested that a trust be appointed to administer the scheme, consisting of one nominee each from the Collie and Bunbury municipal councils, two nominees from the government and a chairman appointed by the government. It is also suggested that the government bear one-half of the capital cost and the Collie and Bunbury municipalities the remainder. An endeavor is to be made to get the scheme financed under the new migration agreement with the British government.

SYDNEY CITY COUNCIL'S RETAIL TRADING ELECTRIFICATION OF SYDNEY RAILWAYS

The Electrical Employers' Association of N.S.W. has forwarded a protest to the Sydney city council against the latter body's proposals to enter the field of retail trading in electrical supplies. The association points out that the proposal is in direct opposition to that made to the association by Mr. Forbes Mackay, general manager of the department, in which it was agreed that the electrical traders should join with the city council in defraying the cost of an extensive publicity scheme to popularise the use of electricity in the homes of consumers, particularly in respect of labor-saving devices for domestic use. It has further pointed out that the members of the association have spent large sums in publicity, education propaganda, and personal demonstrations of electrical equipment, thus increasing the demand for electrical energy from the city council.

In answer to a deputation from the association, the lord mayor recently stated that a special committee of the council has been appointed to investigate the trading proposition. The committee will hear evidence from technical men, and the association is at liberty to send representatives to state its views. All aspects of the matter will receive careful consideration.

LONG TRANSMISSION SPANS

The Pacific Gas and Electric Co., of California, U.S.A., has had some awkward problems to solve in the building of its new 220-kv. transmission line. The principal difficulty is in traversing some five miles of delta lands near the confluence of the Sacramento and San Joaquin rivers east of San Francisco bay. Large spans are necessary across the rivers and there is no land to give suitable foundations for dead-ending. The three principal spans are 4,135 ft., 3,175 ft. and 2,250 ft. long respectively, and the difficulty is increased by the fact that the conductors must be at such a height that clear waterways will be left for navigation.

The method of support that has been adopted provides for high towers on the river banks, designed to take the dead weight of the conductors and the wind pressure, and for anchoring the wires to short sturdy strain structures set some distance back. The tallest of the supporting towers is 459 ft. high, while the strain towers are 100 ft. high. The conductors are of mixed copperweld and copper, of 0.947 in. diameter, and are loaded to a maximum of 20,500 lb. The spacing is 25 ft. vertical and 38 ft. horizontal. The conductors are anchored to the strain towers by quadruple strings of suspension insulators.

The inauguration of electric traction on the Sydney suburban railway system was marked by the commencement, on February 28, of electric passenger services on the line. Steam trains are still running on the route, but they will be gradually being replaced by the electrics in possession of the city council. The next line to be electrified is the line to the town, on which services will be commenced in July.

The electric trains are of the multiple unit system. A motor car and a trailer make up a unit, and these are coupled to form two, four, six or eight car trains. The cars have been in operation for varying periods in steam service and are being equipped for electric traction as required. The motor cars are of two types, but have identical electrical equipment. Some of them are wooden cars that have been in service since 1916, and others are of the all steel type recently introduced. The trailers are older wooden coaches that have been widened and altered to conform with the newer cars. The seating accommodation of the all steel cars is 79, and that of the older cars 68. At present 150 motor cars and 150 trailers are being prepared.

The equipping of the cars for electric traction is being carried out by the Metropolitan-Vickers Electrical Co., of England. Each motor car has two 360 h.p. motors axle hung and geared to the wheels of one bogie. The control is of the electro-pneumatic type. A motor generator set is carried to convert from the supply voltage to 36 volts for the control system and lighting. The energy is taken from a 1,500-volt d.c. trolley wire with catenary suspension. The wires are supported from steel structures normally spaced at 240-ft. centres. The energy is generated in the railway department's power station at White Bay, and is converted to direct current for the trolley wire in converter substations placed at convenient positions.

DISTRIBUTING DEPOTS FOR BRIQUETTES

The Victorian electricity commission has decided to open about 12 depots for the sale of brown coal briquettes at railway sidings in the Melbourne metropolitan area. The object is to provide storage from which fuel merchants can draw supplies as required. The minimum quantity sold will be one ton and the price to the trade will be 40/- per ton. It is stated that the retail price, at which merchants will sell, will be 2/8 per cwt., and that the commission will sell to the public at 42/6 per ton. There will be no delivery or assistance in loading, but bag holders, forks and shovels will be provided. The commission anticipates a strong demand for briquettes in the coming winter.

ADELAIDE TRAMWAYS

The Adelaide municipal tramways trust has issued its thirty-eighth half-yearly report and statement of accounts, covering the six months ended Jan. 31, 1926. During the period certain important constructional works have been brought to completion, the chief of which is the erection of a reinforced concrete bridge over the railway at Mile End. This bridge was opened to traffic on December 22. The duplication of the main line from West Terrace to the new terminus into the new show grounds has also been completed. Amongst the works still in hand are the extension of the power station buildings to accommodate the new 10,000 kw. turbo-alternator at present on order from England. The condenser plant and air cooler for this set have already arrived and are in course of installation.

During the period 15 new cars have been put into service on the tramway system, comprising 11 drop centre bogie cars and four journey one-man safety cars. In addition the second 20 Mack motor buses, with bodies built by Holdens Motor Body Builders Ltd., have been put into service, making 40 Mack buses now running.

The total revenue for the six months was £345,827, and the total operating expenses (including items written off, £1,344) amounted to £255,674. The amount available for appropriation, therefore, was £90,153. To this is added £1,024, being balances brought forward, making a total amount for appropriation of £91,177. This was divided as follows:—Balance for renewals, £17,977; interest, £62,503; amount paid reduction of advances for construction, £10,697.

The act under which the tramways trust operates anticipates that one-sixtieth should be paid off the construction money advanced by the government every half year if the net revenue is sufficient. This one-sixtieth would be £46,909. For some time past the net revenues have been insufficient to meet this obligation, so that there is now a considerable sum not paid off. At the end of the previous six months this stood at £72,514, while at the end of the period under review it was £114,233. Thus there is actually a deficit for the period of £41,719. The total amount reserved out of revenue after 14 years' operation of the full electric traction system is £1,004,957.

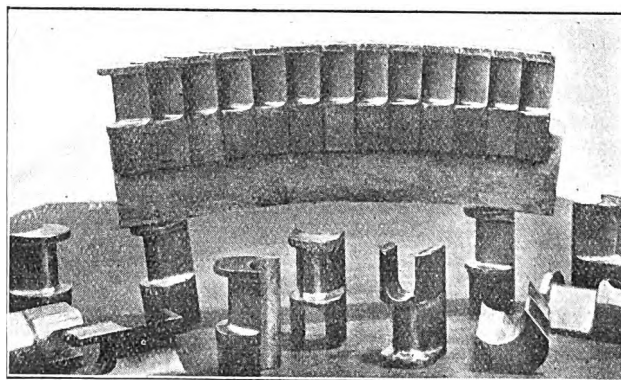
Twelve months ago the trust decided to remove the surcharge on Sunday and holiday fares. During the subsequent period the number of passengers carried has increased by 12.06 per cent, and the revenue has decreased by 17.64 per cent. The increase of passengers is greater than was estimated, consequently the decrease in revenue is less than the estimate.

The greater portion of the losses on the

operations of the trust have occurred on the Port Adelaide traction system. Actually the Adelaide system has practically held its own in spite of all adverse conditions. The newly inaugurated motor bus system is now adding to the deficit, for up to date the losses on it amount to £8,820, while an amount of £639 for repayment of advances on construction has not been met.

TURBINE CONSTRUCTION IN AUSTRALIA

In a recent number of the "Commonwealth Engineer" a short account was given of an interesting piece of work carried out in an Australian engineering shop, viz., the manufacture of a complete nozzle plate and blade disc for a 2,500-kw., 3,000-r.p.m. steam turbine. The machine comprised portion of the power plant of the Broken Hill Associated Smelters at Port Pirie, S.A. A breakdown occurred which necessitated immediate repairs, the damaged parts being the nozzle plate and the first Rateau wheel. As it was not desirable to wait until new blading could be obtained from overseas, the job was put in hand in the company's own workshops.



Turbine Blades Machined at Port Pirie

The casting for the nozzle plate was supplied by Messrs. J. and R. Forgan, of Port Pirie, and the forging for the disc was made by Vickers Commonwealth Steel Products Ltd., Waratah, N.S.W. The machining of these parts, the manufacture and fitting of the blading, and the balancing of the finished blade disc were wholly carried out in the workshops of the B.H.A.S. The blades were machined from solid 1-in. square gunmetal bars. The wheel, when complete, measured 4 ft. in diameter and contained 509 pieces. The assembly was tested at all speeds from zero to 3,000 r.p.m., and at the first test showed absolutely no vibration. The machine was fully loaded and put on the line without any hitch whatever. The whole of the work was carried out under the personal supervision of the plant engineer at the works, Mr. J. Ahern, who designed all the special jigs and tools used in the manufacture of the blading.

DOMESTIC ELECTRIFICATION PROPAGANDA

The British Electrical Development Association is continuing its excellent publicity work on behalf of the use of electricity. It is issuing a steady stream of attractive pamphlets and bulletins descriptive of various applications of electricity in the home and in commercial service. These publications are supplied to electrical dealers throughout the country for distribution to the public. A batch just issued includes an attractive illustrated booklet entitled, "Electricity in the Home," which draws attention to the many uses to which electricity can be put, and to its numerous advantages. Other pamphlets draw attention to the necessity for adequate wiring in houses, and point to what has already been done with domestic electrification in various parts of the country. The publicity work carried out by this excellent institution should do much to further the efforts of electric supply authorities and electrical traders to extend the field of their operations, and should result in lasting benefit to consumers of electricity.

THE SOUTH AFRICAN TURBO-ALTERNATOR SMASH

In the December number of the "Electrical Engineer" brief reference was made to the accident which occurred at the Vereeniging power station of the Victoria Falls and Transvaal Power Co., South Africa, on December 8, when an alternator burst asunder. The "South African Mining and Engineering Journal" has published an account of the occurrence and of the resulting damage to the power station. The generating plant at Vereeniging comprises two 9,600 and two 12,000 kw. turbo-alternators, and it was one of the smaller machines, installed about 12 years ago, which broke up.

The accident was brought about through the tripping of one of the other sets throwing a sudden overload on the 9,600-kw. machine. The strain evidently found a weakness in the rotor shaft of the alternator, which fractured between the rotor itself and the centre main bearing. This allowed the rapidly revolving rotor to foul the stator. In consequence both rotor and stator were smashed to pieces. Several large portions travelled through the roof and end gables of the engine room and were found as far as 300 yd. distant. Part of the rotor forced its way through the engine room floor towards the next turbo-alternator. A spare rotor was lying in the way, and this was bumped up against the alternator, fracturing its feet, moving it on its bedplate, and shearing the end-shield bolts. The spare rotor was severely

damaged and the top of the alternator carcass was badly holed by flying metal. The alternator on the opposite side of the smashed unit sustained damage to the end shields, but both it and the machine next again were soon put back on load. The machine which had been moved on its bedplate was put back on load a week later.

The material damage was very spectacular, but it might have been worse, and it is satisfactory to record that no injury was sustained by any member of the station staff. At the time of publication of the account the conditions which gave rise to the failure of the shaft had not been definitely ascertained.

YALLOURN

Receipt is acknowledged of an illustrated brochure entitled "Yallourn and the Associated State Electricity Schemes of Victoria," forwarded with the compliments of the attorney-general of the state, who is the administrator of the state electricity commission acts. It gives a summarised account of the activities of the Victorian electricity commission from the inception of its undertakings, with some description of the plant installed for coal winning, manufacture of briquettes and generation and distribution of electrical energy. The text and illustrations convey a fair general idea of the nature and scope of the commission's activities. The publication does not aim to be a text book, and therefore contains little of real value from an engineering point of view. Nevertheless, it should be of interest to both technical and non-technical readers.

DRY WEATHER CAUSES LINE FLASHOVERS

Several flashovers have occurred recently on the Victorian electricity commission's 132-kv. transmission line from Yallourn to Melbourne. These have been brought about by the present long spell of dry weather. The absence of rain has allowed dust to accumulate on the insulators, and the cool night temperatures experienced on some sections of the line have brought about condensation of atmospheric moisture, which, mixing with the dust, has provided paths of comparatively low resistance to the voltage stress across the insulator surface. The flashes have caused a good deal of trouble to the operating engineers, but there has been little inconvenience to consumers as the peak load steam station at Newport, in the metropolitan area, has been able to cope with the demand. The trouble has been overcome by cleaning the insulators by hand.

MERCURY ARC SUBSTATION

The defence department is making extensive alterations in the electric supply to the naval base at Flinders, Vic. Energy has been generated locally for power and lighting purposes, the distribution being carried out at 460/230 volts d.c. A change-over is being made, however, to bulk supply from the state electricity commission. The bulk energy will be transmitted from the commission's extra-metropolitan distribution system at 6,600 volts three phase. In order to make it available to the existing plant at the base it will be stepped down and rectified in a substation. The substation plant will consist of a transformer and a 275 kw. mercury arc rectifier, built by Messrs. Brown, Boveri and Co., of Switzerland, and supplied and installed by Messrs. Gibson, Battle (Melb.) Pty. Ltd. This equipment will give a supply at 460 volts. Energy at 230 volts for lighting will be obtained on the three wire system by means of a balancer.

THE IMPORTANCE OF GOOD FACTORY LIGHTING

The executives of large manufacturing concerns are coming to realise that good lighting for working places is not an expense but an investment. Experience has proved that it not only makes for greater working comfort for operatives but prevents accidents, decreases spoilage and brings about considerable increases in production. In a recently published pamphlet from America several instances are given of tangible improvements in production arising from the installation of efficient systems of illumination, proving that light can actually earn profits for the consumer when properly used. One manufacturing concern recently carried out exhaustive tests over a considerable period with a view to determining the effect of lighting on production. Improving the lighting system and increasing the intensity of illumination by gradual steps, it found that the production increased correspondingly until, at the most efficient point, a 25 per cent increase in production over that under the old conditions was recorded.

Adherence to old and inefficient lighting is undoubtedly a handicap to industry, but unfortunately the poor quality of an installation is often not realised. Nobody—not even a lighting expert—can accurately judge lighting by merely looking at the appearance of a lighted room, because the eye accommodates itself to gloom and leads to deceiving conclusions. The only way to be sure about the condition of lighting is to measure it. The foot-candle meter is the measuring instrument, and it should be

applied to determine the efficiency of every installation. Definite standards of lighting for different industries have been drawn up as the result of experience, and industrial executives should spare no effort to bring their lighting up to these standards.

There is now no question as to which is the best source of light. Electricity has advantages which give it a universal ascendancy over all other illuminants. Science and art have been combined in its utilisation so that fittings are available that will direct the light just where it is wanted, in the most efficient manner, and will lend a pleasing appearance to the installation. The advantages of good lighting are proved; the equipment is available for securing them; therefore there is no excuse for continuing to operate with poor illumination in working places.

NEW POWER STATION FOR LONDON

The North Metropolitan Electric Power Supply Co. has placed a contract with the Foundation Co. Ltd. for the first section of a new power station to be erected at Brimsdown in the London area. The generating plant is to be of 40,000 kw. capacity, and the station will operate on pulverised fuel.

The whole of the steam raising plant is being supplied by International Combustion Ltd. as a sub-contract. It comprises five Babcock and Wilcox boilers, with normal heating surface of 10,100 sq. ft. each, which are to be fired with pulverised fuel on the Lopulco system. Each boiler is to be fitted with Lopulco patent water screens and Murray Usco fin furnaces, which will increase the heating surface to 11,000 sq. ft. Howden air preheaters and Foster type economisers and superheaters are to be used in conjunction with the boilers. The station, when complete, will be the largest in the London area operating entirely on pulverised fuel.

The New Zealand public works department will shortly put in hand the work of electrifying the railway tunnel between Christchurch and Lyttelton.

The Melbourne city council is calling fresh tenders for a 5,000 or 5,500 kw. turbo-alternator. The specification invites manufacturers to quote for as much of the plant as possible to be made in Australia. The tenders close on June 16.

Electric lighting is being installed in the Waitomo caves, N.Z. The main corridors and caverns are already lit, but there is some special work to be done, including the installation of certain floodlights. The energy is derived from the public works department's Horahora power station.

Radio News

Mr. James G. Pritchard, hon. treasurer of the Association for Developing Wireless in Australia, New Zealand and Fiji, has left Sydney on a tour abroad.

Tests have been carried out recently with the new 5-kw. transmitter for the Queensland government broadcasting station, 4QG, Brisbane. Reports have been received from New Guinea and Tasmania.

Further successful tests have been carried out with two-way radio telephone communication between Great Britain and the United States. It is possible that a commercial international telephone service may be established within 12 months.

Mr. D. Macdonald, consulting engineer to the broadcasting stations 3AR, Melbourne, 5CL, Adelaide, and 7ZL, Hobart, is proceeding to America to investigate radio matters. He will make enquiries regarding plant for effecting improvements to the stations under his supervision.

It has been proposed that wireless telephone receivers be installed on the Australian trans-continental trains, so that passengers may be able to keep in touch with world news and may have the benefit of broadcast programmes. The matter is receiving official consideration and experiments with radio on trains in other parts of the world are being watched.

Philips' Glow Lamp Works Ltd. advises that it is now manufacturing transmitting valves under classifications and ratings as follow:— Z.1, 5 watts; Z.2A, Z.2B, 20/30 watts; Z.3, 125 watts; Z.4, 250 watts; Z.5, 500 watts. Transmitting tubes for 1 kw. and over are also made, and full details can be had on application to any of the company's agents.

A federal radio conference will be held in Sydney during April for the purpose of considering such questions as copyright charges, patent royalties and methods of collecting license fees. Representatives will be present from government departments, broadcasting companies, radio trading concerns, scientific institutions, the Wireless Institute of Australia, the Australian Listeners' League, etc.

Mr. C. R. Whitelaw, an amateur experimenter, of station 3BH, Benalla, Victoria, has been successful in transmitting speech to Pennsylvania, U.S.A., on a wave length of 36 metres. He communicated first by Morse with Mr. Wright, of Scarborough, N.S.W., changing over later to telephony. In the evening of the same day he

called New Zealand by telephony, and received an answer. On completion of working with the New Zealand station an American station reported that the speech had been heard clearly, though faint.

The Victorian listeners' league has been formed with the objects of protecting and promoting the interests of wireless listeners and of assisting broadcasting concerns to improve and extend their services. Mr. F. A. Campbell has been elected chairman, and Mr. C. M. Hosking is secretary.

The Birmingham Small Arms Co. Ltd., England, is commencing the manufacture of radio equipment. A new company, known as B.S.A. Radio Ltd., has been formed to market the B.S.A. wireless products. An arrangement has been made with Standard Telephones and Cables Ltd., whereby B.S.A. Radio Ltd. will have the benefit of that firm's experience in research and development in broadcast reception. Details of the B.S.A. radio products are not yet available.

A new wireless catalogue under the title "GecOphone Wireless Receiving Sets, Components and Accessories," has been issued by the British General Electric Co. Ltd. It is printed on art paper and profusely illustrated, and includes a glossary of wireless terms, symbols, list of transmitting stations, with their call signs and wave lengths and power and wiring diagrams. A handy feature is that the subject matter has been divided into subsections thus permitting ready reference. Copies may be obtained upon application.

THE SIFTRON

Messrs. Alfred Graham and Co., the well-known English manufacturers of radio accessories, have introduced a useful device, known as the Siftron, for improving the reproduction of sound from a loud speaker. Under ordinary circumstances the current in the plate circuit of the last valve in a receiver consists of two components, the alternating speech current, and a direct current induced by the voltage of the h.t. battery. The former produces speech in the loud speaker, but the latter serves no useful purpose in the speaker and may give rise to distortion. The Siftron consists of an arrangement of a choke coil and condenser, which is interposed between the last valve and the loud speaker, and passes the alternating current to the speaker while causing the direct current to go direct to the h.t. battery. This arrangement does not detract from the volume of sound but generally gives better tone and clarity. The device is mounted in a bakelite housing and equipped with clearly marked terminals. Its overall length is 5 in., its height $2\frac{3}{4}$ in., and

its width $2\frac{1}{4}$ in. A subsidiary advantage arising from its use is that it is immaterial which way the terminals of the loud speaker are connected as there is no direct current to cause demagnetisation. The device may be used with 2,000 or 4,000 ohm loud speakers of almost any type.

VALVES FOR REFLEX CIRCUITS

Reflex circuits have not achieved any great degree of popularity, although they have advantages which should commend them to the broadcast listener who desires economical operation. The principal troubles appear to be in the complication of the wiring and the element of instability. It has been repeatedly proved, however, that with proper selection of the components of the set, and ordinary care in wiring, reflex circuits can be made to produce very good results. The chief points to be watched are the selection of suitable valves and the matching of intervalve transformers with the valves used.

It is probably not generally realised that certain types of valve are not suitable for reflex working, and it may be that fruitless endeavors to use a valve with the wrong characteristics have caused many amateurs to condemn reflex circuits. As is well known, in all reflex circuits a single valve is used to amplify at both radio and audio frequency. This makes it difficult to obtain the best efficiency. For amplification of radio-frequencies, voltage amplification is required, while for audio-frequencies, current amplification is needed. Now, the dual valve first amplifies the high frequency current, which is then rectified by the detector and passed back or reflexed to the dual valve for audio-frequency amplification, after which l.f. power valves may be added. Bearing in mind that no receiver is worthy of consideration which is not capable of giving pure, undistorted results with the necessary volume, in choosing a reflex valve it is necessary to concentrate particularly on its audio-frequency characteristics, sacrificing, if need be, a little of the range possibilities obtainable by characteristics suitable for radio-frequency amplification. Therefore, for reflex working, l.f. amplifying valves will give the best results.

A good l.f. amplifier valve will have a certain length of straight anode current-grid volts characteristic which entails a comparatively low amplification factor and impedance. High frequency amplifiers, however, have high M values, and this is why they are not suitable for reflexing.

It is very important to match the impedance of the transformer primary to that of the valve for whose anode circuit it is intended, and as the majority of commercial transformers have a moderately high ratio, a comparatively low

impedance primary is indicated; therefore, the best results will be obtained if a low impedance valve is used in front of the transformer.

Amongst the valves suitable for reflex service are the Osram types, DE4, DE5, DE2L.F., and DE5B. The first two are power valves and are recommended for use both in the reflex and the power amplifying stage. They work at about 100 volts h.t. and 6 volts grid bias. The DE2 L.F. valve is one of two new types recently introduced for h.f. and l.f. amplification respectively. The filament voltage of both valves is 2 volts, and the current consumption is only 0.12 amp. The l.f. valve has a very low impedance, which makes it especially suitable for reflex circuits. The correct h.t. voltage is about 80, and a negative grid bias of $4\frac{1}{2}$ volts should be used. The DE5B valve is used in circuits employing resistance coupling instead of intervalve transformers. Its h.t. voltage is about 90 and it requires a grid bias of $1\frac{1}{2}$ volts.

With reflex circuits it is particularly important that the correct h.t. voltage and negative grid bias be applied, in order that the valve may be prevented from acting as a rectifier. With the use of valves of types similar to those listed, and with transformers of suitable impedance for operation with the valves, no difficulty should be experienced in operating reflex circuits.

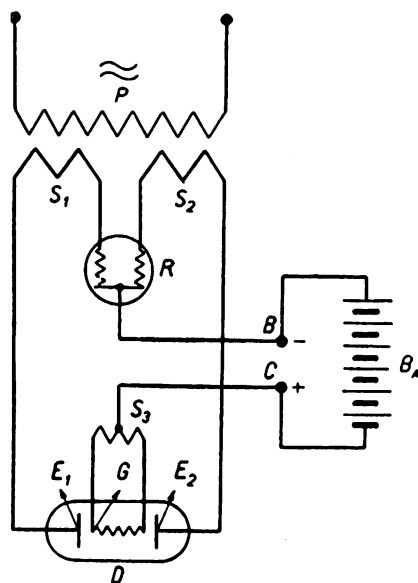
BRITISH BROADCASTING

The British government has recently received a report from a committee appointed to decide upon the nature of the administration of broadcasting services after the expiry of the British Broadcasting Co.'s license on Dec. 31 next. The committee recommends that broadcasting be made a public service; that a corporation consisting of five or seven nominees chosen by the Crown be appointed to take over the staff, contracts and apparatus of the existing company; that the corporation operate the license of the postmaster for at least ten years; that the commissioners be invested with the maximum of freedom consistent with parliamentary control through the spokesmanship of the postmaster-general; and that generous provision be made for experiment and research. Among the minor points are recommendations that the receiver's license fee shall remain at 10/-, blind persons to be licensed free. Every effort is to be made to raise the standard of the programmes, especially the music, and also to meet the claims of those who, though relatively few, desire a larger proportion of educational matter.

The committee emphasises that its recommendations do not imply criticism of the present company, which has raised the broadcasting service to a degree reflecting high credit on British efficiency and enterprise.

THE PHILIPS RECTIFIER

Small rectifiers of many types have been developed lately in response to the demand for simple apparatus for charging accumulators used by radio enthusiasts. Several different principles are employed in their construction, and some very reliable apparatus has been evolved. The bulb rectifier, produced by Philips Radio Ltd., makes use of the rectifying property of the two electrode valve. It is of the full wave type, using both half cycles of the alternating current. It comprises a rectifying bulb, a transformer and a regulating resistance, the whole being mounted on an aluminium base covered with an insulating sheet, and enclosed in a ventilated aluminium housing. The overall dimensions are: height 8 in., diameter 6 in.



Connections of Philips Rectifier

The scheme of operation can be followed from the diagram. D is the rectifying bulb, R the regulating resistance, P the primary winding, and S_1 and S_2 the secondary windings of the transformer. G is the incandescent filament acting as the cathode, and E_1 and E_2 are the anodes of the rectifying bulb. The filament is heated by a third secondary winding S_3 , wound on the transformer core. Ba is the battery under charge, connected through terminals B and C.

The heating of the filament, G, gives rise to an emission of negative electrons. If E_1 has a positive potential relative to that of G, a flow of electrons is set up from G to E_1 , circulating via S_1 , R, B, Ba , C, back to G. This positive potential is attained with every cycle of the supply voltage. During the following half cycle E_2 becomes positive in relation to G, and the

flow of electrons is from G to E_2 , and through S_2 , R, B, Ba and C to G. Thus, a flow of current passes through the battery during every half cycle of the alternating current through the transformer. This flow is in the opposite direction to the flow of electrons and thus passes through the battery from C to B. To obtain a constant current a lamp of variable resistance, R, is used, which gives automatic regulation. This makes it unnecessary to use a regulating resistance or an ammeter. No fuses are required, as even if the battery leads be short-circuited, the current is limited by the lamp resistance.

This rectifier is quite simple to use and the apparatus is foolproof. A plug is provided for insertion into the a.c. supply receptacle, and leads marked + and - are provided for connection to the corresponding poles of the battery. The rectifier works without any attention. If the a.c. supply should fail, the charging of the battery is stopped without danger of discharge. As soon as the supply is restored the charging is automatically continued. The device can be used for charging storage batteries of from 2 to 12 volts potential. The average charging current is about 1.3 amp, and the energy consumption about 55 watts.

SHORT WAVE BROADCASTING

Two of the Sydney broadcasting stations, 2BL and 2FC are experimenting with short wave broadcasting. Programmes are to be sent out simultaneously by the ordinary transmitter and by a special short wave transmitter operating at about 40 metres. The special equipment at 2BL is housed at a short distance from the main equipment and is served by a branch line from the studio. The antenna is a vertical copper rod about 30 ft. high. The aim is to greatly increase the effective range of the broadcasting by making use of the remarkable carrying properties of the short waves.

Improvements have recently been made on the Adelaide-Darwin telegraph line, resulting in the speeding up of communication from 35 to 60 words per minute. Vacuum arresters have been installed for draining the line of high frequency surges set up by lightning.

Work is proceeding satisfactorily on the installation of automatic telephone exchanges in Brisbane. At Albion the racks are in position, cabling has commenced and the installation of the batteries is in hand. At Newmarket the major portion of the work is complete. At the J main exchange the installation of the power plant is now being undertaken.

Trade Notes

Claimants in the estate of Harold H. Herbert, electrical goods supplier, 193 George street, Sydney, are notified to lodge claims immediately, with the official assignee, C. F. W. Lloyd, 182 Phillip street, Sydney.

Change of Address.—A. Beal Prichett (Aust.) Ltd., Australian representatives for Heemaf S.K.A. motors, are now located at Amico house, 5 Parker street, Sydney.

Australian Westinghouse Electric Co. Ltd., as a result of increased business, has opened show-rooms at suite 806, 8th floor, Cathcart house, 15a Castlereagh street, Sydney, where a complete range of domestic appliances and electric lighting fixtures is on view.

Dissolution of Partnership.—Messrs. V. V. Bale and C. R. Woods, carrying on business as electricians, general engineers, etc., at Lismore, N.S.W., under the name of the Lismore Electric Co., have dissolved partnership. Mr. Woods will in future conduct the business, trading under the existing name.

British Insulated Cables Ltd.—The well-known firm of electrical engineers and cable makers, British Insulated and Helsby Cables Ltd., has decided for reasons of convenience and easy reference to shorten its title to British Insulated Cables Ltd. The head office for Australia is at 499 Little Collins street, Melbourne.

Insulating Materials.—Mr. W. G. Sleightholm, late of the Mica and Insulating Supplies Co., has set up in business as a supplier of insulating materials at 175 William street, Melbourne. He carries stocks of all the usual insulating materials used in electrical manufacturing and repair work, and will give prompt attention to all enquiries.

Change of Agency.—Arthur Leplastrier and Co. Pty. Ltd., of Sydney and Melbourne, have taken over the representation of Mather and Platt Ltd., London, and Brook, Hirst and Co. Ltd., Chester, England, manufacturers of motors, pumps, rotary converters, etc., and of ironclad switchgear respectively.

Economic Heaters Ltd. has been formed with capital of £20,000 to purchase the rights of a patent liquid heater and carry on the manufacture and sale of the device. The company will also trade as ironfounder, mechanical engineer and manufacturer of agricultural implements. The address is 11 Alberta street, Sydney.

Ironite Electrical Products Ltd., with nominal capital of £33,000, has been formed in New South Wales to acquire the interest of Mr. G.

Brown in six inventions, to sell, let or grant any patent rights, etc., and to pursue the business of electricians and engineers. The first directors are J. H. Mostyn and G. R. Brown. The registered address is 95a Pitt street, Sydney. The principal patent is in relation to a standard fitting for use with switches, fuses, ceiling roses, junction boxes, etc., giving an all metal enclosure of the conductors. It is claimed that this fitting will be cheap to manufacture and simple to install and will give perfect safety against fire or shock arising from the wiring installation.

Dissolution of Partnership and Removal of Premises.—Messrs. W. Cumming and J. Cumming, trading as W. Cumming and Co., electrical engineers and contractors, Melbourne, advise that owing to the expiration of the lease of their existing premises and the retirement of Mr. J. Cumming, the business will be carried on after Mar. 31, 1926, under the same name, at McKillop house, McKillop street, Melbourne. The firm will continue in the business of installation and general electrical contractors and will maintain a service for electrical repairs, armature winding, etc.

New G.E. Edison Lamp.—The General Electric Co. of America is manufacturing Edison lamps of a new type, frosted on the inside. Frosting in this way gives excellent light diffusion and allows of the outside of the globe being perfectly smooth and easy to clean. In addition the appearance of the lamp is pleasing, and the light transmission highly efficient. Lamps of this new type have a high decorative value, for when alight they give a pleasant diffused light without glare, and when not in use the pearl-like surface of the glass reflects delicate shades from the background on which it is placed. Thus at all times the lamp harmonises with the decorations. At present the new type is available in capacities of 25, 40, 60 and 100 watts.

The Tungstone Accumulator.—Advantages as regards sturdiness of construction, reliability and accessibility are claimed for the Tungstone accumulator, a product of British origin manufactured by the Tungstone Accumulator Co. Ltd., London. The accumulator is of the lead-acid type with the plates specially constructed to combine strength, lightness and efficiency. The active paste is held by a grid of pure lead supported on a light frame of antimonial lead. Each cell is made up separately in an antimonial lead container. The plates are kept in position by ebonite end separators. The whole assembly of plates and separators may be readily lifted out of the container and taken to pieces for inspection. The cell terminals are of the screw type equipped with patent lock nuts and the cells may readily be coupled up into batteries. The cells are made up in various types and

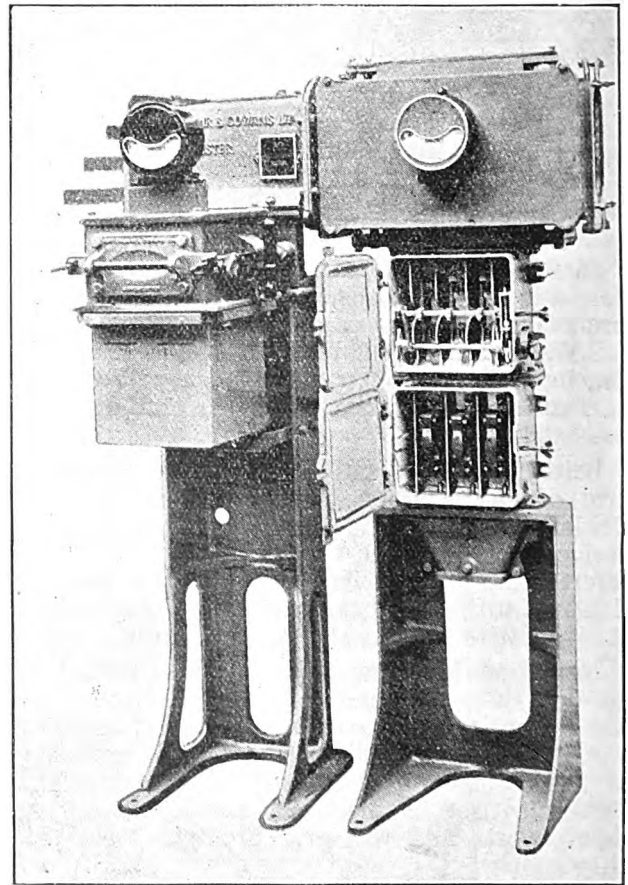
sizes and may be obtained assembled to form automobile batteries or batteries for radio work, both low tension and high tension. A special feature of the Tungstone is that the plates are given a partial charge at the factory so that, when assembled with acid, sufficient energy is available, without charging, for such services as car lighting for a short period.

Switchgear Abstracts.—Messrs. Johnson and Phillips Ltd., the well-known electrical engineers and cable manufacturers, have commenced the issue of a series of booklets entitled, "Switchgear Abstracts." In an editorial note to the first of the series they say, "The field of electrical engineering is so wide that few engineers can claim a specialised knowledge of more than one or two branches, and for our many friends who have to use switchgear, but are perhaps more familiar with steam plant or cables we have prepared a source of information which will answer most of their switchgear queries briefly, and without necessitating a long search through more comprehensive and ambitious works." This first volume deals with the different types of switchboard in general use, enumerating their various advantages and pointing out their special fields. Brief descriptions of each type of board are given, accompanied by illustrations. Reference is made to some of the electricity regulations under the British factory and workshops acts, and to their bearing upon switchboard design and construction. As an assistance in choosing the correct type of switchboard for a specific application tabulated comparisons are given of the prices of the different types and the relative amount of floor space they will occupy. This brief description and comparison covers d.c. boards and low, medium and high tension a.c. equipments. The booklet concludes with a schedule of the minimum information required in a switchgear enquiry.

Ironclad Airbreak Switchgear.—Messrs. Switchgear and Cowans Ltd., Manchester, England, have recently developed a line of totally enclosed, ironclad, unit type, safety interlocked, airbreak switchgear, using a type of movement for the switch operation which has hitherto only been used in oil switches. The gear is designed with liberal dimensions and is very sturdily built. No fragile material is used in the construction, and it is hoped that breakages and the usual troubles common to airbreak switchgear have been practically eliminated.

The illustration shows a pedestal type switch-fuse of the new line compared with an oil switch for similar service. The switch and fuse cases are made of cast iron with close fitting, hinged, flanged covers. The covers are interlocked so that they cannot be opened unless the switch is open or the fuses are dead. Between the poles of the switches and fuses arc barriers

of fireproof insulation are fitted, dividing each case into separate compartments for each pole or phase. The moving contacts of the switch are strong, hard drawn copper bars, held rigidly by malleable iron clamps at their centres where strong tubes of bakelite insulation surround them. The two or three contact bars of a double or triple pole switch, respectively, are mounted on a steel carrier bar to which the operating mechanism imparts a straight back-



Ironclad Oil Switch and Air Break Switch Fuse Units

ward and forward movement. The carrier bar is arranged so that its ends run in parallel guides attached to the case. The operating gear is equipped with springs which give a quick make and break of contact independent of the manner in which the switch handle is actuated. The fixed contacts are of high conductivity copper, of the bent-over spring type, mounted on strong gun-metal bases. The two sets of upper and lower contacts are firmly clamped by their bases to stout steel bars which are fastened to the back of the case. Between the bends, each bar is covered with a thick tube of bakelite insulation. The bakelite tubes on these two bars and on each of the moving contact bars, are the only insulation on the

switch. The fixed contacts correspond with the upper and lower ends of the moving contacts, thus providing two simultaneous breaks per pole. A very liberal area of contact surface is provided by the double contacts. The gunmetal bases of the fixed contacts form the terminals on which provision is made for bolting up connecting strips or for attaching cable sockets. The contacts and terminals are situated right at the back of the case where they are not liable to be inadvertently touched when the cover is open. The fuses are made up with the patent S and C fuse carriers which have already been described in these columns.* The handles and patent fuse baffles are moulded of an insulating material which has great mechanical strength and is non-hygroscopic.

The switch and fuse cases are made for connecting up with other similar units to form pedestal boards, as shown, or totally enclosed ironclad boards in various combinations. The top and bottom flanges, where connection is made, are identical for all switches and fuses of the same capacity. Cable boxes to suit any class of multicore cable can be fitted, either straight or right angled. Also pipe adaptors for two or three single core cables can be fitted. Instruments are fitted when required, either on the front plates of the busbar chambers in the case of double tier equipments or on the top of the switch or fuse units in the case of single tier equipments. The switches and fuses are standardised in five sizes from 60 amps up to 400 amps, double and triple pole, and can be used up to their maximum capacities on either a.c. or d.c. circuits up to 650 volts. Where the current in any one circuit, either incoming or outgoing, is in excess of 400 amps an oil-immersed circuit breaker is used in place of a switch and fuses. The switch and fuse units are made to line up with the standard S. and C. oil-immersed pedestal units, as indicated in the illustration.

The switchgear is heavily built for continuous operation and is successfully employed in many situations where conditions prevent the use of open switches and fuses or ordinary ironclad switches and fuses. Further particulars and prices may be obtained from the Australian representatives of the manufacturers, Messrs. Horrocks, Roxburgh Pty. Ltd., Melbourne.

Messrs. Johnson and Phillips Ltd., who recently suffered the loss of their Sydney office premises by fire, announce that they are carrying on in temporary offices at 279 Clarence street, and after March 31, will be established at 203 Clarence street. The firm is now able to resume deliveries of C.M.A. products from bulk store, and wishes it understood that no salvage stock is carried.

*"Electrical Engineer," vol. 1, p. 184.

New Publications

The Practical Electrician's Pocket Book. Edited by H. T. Crewe. S. Rentell and Co. Ltd., London. Pp. 585. Price in England, 3/-.

This is the twenty-eighth edition of this well-known pocket book and it incorporates many alterations and improvements upon previous editions. The sections dealing with a.c. and d.c. dynamo electric machines and the sections on a.c. theory and transformers have been entirely re-written. Other sections also have been carefully revised and brought up to date. New chapters have been added, dealing with power factor correction, localisation of cable faults, and a.c. protective systems. The book is the work of experts in the various branches, and constitutes an excellent reference work for practical electricians.

Electrical Power and National Progress. By Hugh Quigley. George Allen and Unwin Ltd., London. Pp. 155. Price in Australia, 11/6.

During the last few years there has been manifest a growing public desire for information on some of the economic aspects of the generation and utilisation of electric power. In Great Britain the electric power industry has recently been drawn into the sphere of politics, for it is recognised that the industrial development of the country is largely dependent upon the amount of power used. This book embodies the findings of a special survey of the present position of electricity supply in Great Britain carried out by the economic and statistical department of the British Electrical and Allied Manufacturers Association. It deals with the broad fundamentals of the question, handling the subject in such a way that it should be clear, not only to the engineer, but to every citizen who is interested in the industrial and economic progress of his country. Though written with special reference to Great Britain, its application is wide enough for it to be of universal interest. It shows how great the achievements of the electrical industry already have been; it deals with various aspects of the important questions of coal conservation, establishment of super power schemes and industrial electrification; it points out some of the many advantages that arise from the use of electricity; and it indicates the lines along which the economic utilisation of power resources should be carried in the future. Examples and statistics from many parts of the world are used to illustrate the various points. The volume gives a broad general summary of the economic aspect of electricity supply and directs attention to the value of electrical energy in industry. As general publicity for electricity supply it performs a very valuable service.

Lighting and Power

Albion Park, N.S.W.—The question of an electric supply scheme for Albion Park and Shellharbor is under consideration and the council is obtaining an estimate of the cost.

Ararat, Vic.—The municipal council contemplates a reorganisation of the electric supply undertaking.

Avoca, Vic.—It is expected that the electric supply will be available within a few weeks.

Ballan, Vic.—The electricity commission has approved the application of a private syndicate for permission to undertake electric supply in the district.

Bega, N.S.W.—State Electric Lighting Ltd., with capital of £25,000, has been formed to exercise a franchise for the supply of electricity in the district. Mr. E. S. Spooner, of 115 Pitt street, Sydney, is the secretary, and Mr. H. J. Hoggan is consulting engineer.

Benalla, Vic.—The date on which the electricity commission will take over the electric supply undertaking has been altered from April 2 to May 1.

Coleraine, Vic.—The Coleraine and Western District Butter Factory Co., which gives electric supply in the town, has announced its intention of raising the tariff from 1/- to 1/2 per unit.

Devonport, N.Z.—The borough council has approved of the transfer of the municipal electricity supply undertaking to the Waitemata power board. The board guarantees not to raise the price of energy for at least four years. The council is endeavoring to have the transfer completed by March 31.

Edithburg, S.A.—The generating plant at the council's new electric supply station consists of a 22 h.p. Clayton crude oil engine driving a variable voltage Electromotors d.c. generator. There is also a storage battery consisting of 120 E.P.S. cells, with capacity of 400 amp. hours. The variable voltage generator dispenses with the need of a booster for battery charging. The distribution is carried out at 200 volts d.c. and the prices charged for energy are:—Lighting, 1/3 per kelvin; domestic power, 6d.; industrial power, 4d. and 2d. (the latter for consumption above 100 kelvins per month). At present there are 70 consumers. The installation was carried out but Messrs. Deland, Wyllie and Davies Ltd., of Adelaide, to the specifications of Mr. P. H. Bedser, chief engineer of the firm.

Ferntree Gully, Vic.—The two-part tariff imposed by the electricity commission is having the effect of restraining many owners of week end houses from becoming consumers of electricity. The fixed service charge, independent of the amount of energy used, imposes an undue burden upon those whose houses are closed during the greater part of the year.

Hastings, N.Z.—The borough council has accepted the tender of Messrs. Richardson and McCabe for the supply of a 500 h.p. crude oil engine for the electricity undertaking. The total cost, including the price of the generator, switchboard and erection, will be about £9,000.

Inglewood, Vic.—The Bridgewater memorial hall committee has decided to install an electric lighting plant at a cost of £236.

Invercargill, N.Z.—The operations of the Southland power board during the six months ended October 31, 1925, realised gross revenue amounting to £14,539. The sales of energy were as follows:—Lighting, heating and power, 584,640 kelvins; cooking, 303,502 kelvins; water heating, 71,311 kelvins; bulk supplies, 116,578 kelvins. The average price per unit for retail supplies was 3.2d.

Katoomba, N.S.W.—The municipal council has agreed to increase the salary of Mr. J. Storer, acting electrical engineer, to £750 per annum, and to invite applications for the position of permanent electrical engineer.

Kilmore, Vic.—The demand for electrical energy is increasing to such an extent that the present suction gas plant will shortly be unable to cope with it. The shire council will probably enquire whether the electricity commission can give bulk supply to the town.

Kyneton, Vic.—Representatives of the Newham, Bulla, Metcalf and Romsey shires waited upon the electricity commission recently with a request for electric supply throughout the districts. The population of the area is 20,800 and the number of dwellings 4,800. The matter will be investigated.

Laidley, Q'ld.—Progress is being made with the scheme for installing an electric supply undertaking. Over 90 householders have promised to take supply, and an application is to be made for an order in council authorising the raising of a loan. Tenders for the erection of the power station are to be invited. Mr. A. E. Harding Frew is consulting engineer.

Lawrence, N.Z.—The borough council has decided to link up with the Otago power board so that the board can supply electrical energy throughout the district.

Levin, N.Z.—The demand upon the Horowhenua power board for supply of electricity is considerably heavier than was anticipated in the estimates. The original quota of bulk supply from the public works department was 1,200 h.p., which was estimated as likely to meet requirements for five years. Within one year, however, the demand has reached 1,300 h.p. There is still rapid electrical growth in the district and it now appears that at the end of the second year the demand will exceed that anticipated for the tenth year. There is a possibility that the bulk supply will have to be limited as there is a rapidly increasing demand upon the source of energy, the Mangahao power station. The public works department is pushing ahead with the new hydroelectric scheme at Waikaremoana in order to be able to relieve Mangahao which supplies several power boards with rapidly growing loads.

Lower Hutt, N.Z.—The demand for electric supply from the Hutt Valley power board is growing so rapidly that the public works department has been approached in the matter of increasing the supply.

Manilla, N.S.W.—The municipal council has agreed to a proposal from the Tamworth municipality for the supply of electricity in bulk. Energy will be conveyed by a high tension line approximately 20 miles in length.

Maryborough, Vic.—The borough council is raising a loan of £2,500 for extensions to the electric supply.

Morpeth, N.S.W.—The West Maitland council has completed the extension of electricity supply to the town.

Mullumbimby, N.S.W.—The official switching on of the hydroelectric scheme took place on March 6. The distribution system is 415/240 volts, 50 cycle, three phase a.c. Mr. W. Corin, of Sydney, is consulting engineer for the installation.

Napier, N.Z.—The Hawke's Bay power board is raising a loan of £200,000 for electric supply purposes.

Nar-Nar-Goon, Vic.—A company is being formed to undertake the supply of electricity to the district.

Narrabri, N.S.W.—The municipal council is making extensions to the electric supply plant and has accepted the tender of Messrs. Buzacott and Co. Ltd., for one 95 h.p. twin cylinder and one 45 h.p. single cylinder Vickers-Petters crude oil engine, together with 480/240 volt d.c. Crompton generators. The drive will be by Lenix belt gear.

Ouyen, Vic.—Mr. J. B. Sullivan has been appointed engineer in charge of the Walpeup shire council's electric supply undertaking in succession to Mr. A. Mathers, who has resigned.

Peak Hill, N.S.W.—Messrs. A. C. F. Webb and Burgess, consulting engineers, Sydney, are furnishing a report to the municipal council on a proposed electric supply undertaking for the town.

Port Fairy, Vic.—The work of extending electric supply by the electricity commission into country districts has been so retarded owing to shortage of loan funds that no work can be undertaken to give supply to Port Fairy for at least 18 months. A power survey of the district, however, will be undertaken immediately.

Pukekohe, N.Z.—The supply of electricity to the borough has been changed over from the suction gas plant previously operated by the council to bulk supply from the Horahora hydroelectric station of the public works department. The distribution is in the hands of the Franklin power board.

Rochester, Vic.—The Commonwealth Electric Co. is taking steps to install new crude oil generating plant to take the place of the equipment destroyed in the recent fire. The local butter factory has made an engine available for giving a limited temporary supply until the new plant is installed.

Rylstone, N.S.W.—The shire council has accepted the tender of McDonald Bros., Sydney, for the high and low tension reticulation work in Rylstone and Kandos.

St. George, Q'ld.—The Balonne shire council has resolved to borrow £13,500 from the A.M.P. Society for works including an electric supply installation.

Tully, Q'ld.—The state government has placed an order with Messrs. Noyes Bros. (Sydney) Pty. Ltd., for plant for the Tully central sugar mill electric supply scheme. This includes two 75 h.p. three cylinder Vickers-Petters crude oil engines direct coupled to 50 k.v.a. Peebles alternators. The generating voltage is 415/240, 50 cycle three phase a.c.

Wairoa, N.Z.—The electric supply undertaking used 147,722 kilowatts of energy during the quarter ended Dec. 31, 1925. The consumption has increased by 48 per cent over that for the corresponding period of the last year.

Walgett, N.S.W.—The shire council has accepted tenders for plant for the electric supply undertaking. The distribution system will be 480/240 volts d.c. Messrs. A. C. F. Webb and Burgess are the consulting engineers.

Wodonga, Vic.—Residents of the town are desirous that the electricity commission will take over the supply of energy. The commission has stated that in the event of it taking over, the plant now operated by the Wodonga Electric Supply Co. would be of no use to the commission.

Current Prices for Electrical Supplies

The quotations in this list represent the average retail selling prices ruling in Melbourne during the month of publication. These prices are subject to bona fide traders' discounts. Special rates are obtainable in most cases for large quantities. In general Sydney prices are slightly lower.

Adaptors—

Hardwood	doz.	11/3
Parallel	each	6/6

Blocks—

3 in. round	gross	21/3
3½ in. round	gross	21/3
6 in. x 3 in. rectangular	doz.	6/3
9 in. x 3 in. rectangular	doz.	7/6
6 in. x 6 in. square	doz.	12/6

Bushes—

½ in. ideal metal	gross	7/6
¾ in. ideal metal	gross	7/6
1 in. ideal metal	gross	8/9
¾ in. plain wooden	doz.	1/6
1 in. plain wooden	doz.	1/8
1 in. plain wooden	doz.	2/

Bells and Bell Material—

Bell transformers	each	10/6
1½ volt dry cells	each	3/
Bell wire—1/029 d.c.c.	1,000 yd.	32/6
1/036 d.c.c.	1,000 yd.	42/6
1/029 d.c.c. and i.r.	1,000 yd.	50/
1/036 d.c.c. and i.r.	1,000 yd.	60/
No. 2 porous pots	each	2/
No. 2 jars	doz.	8/9
No. 2 zincs	each	1/3
Salammoniac	lb.	1/3
2½ in. wood box bells	each	4/6
2½ in. iron box bells	each	4/6
3 in. wood (church gong)	each	18/4
Bell presses	from each	3/9

Pocket Lamp Batteries—

Batteries, pocket lamp	each	1/10
2-cell batteries	each	2/5
3-cell batteries	each	2/8

Ceiling Roses—

		English	Japan
2-plate	doz.	10/5	5/5
3-plate	doz.	13/9	7/6

Connectors—

1-way, porcelain	doz.	2/6
2-way, porcelain	doz.	4/
3-way, porcelain	doz.	5/

Counterweights—

Porcelain	each	2/6
Brass	each	5/6
Shot for same	lb.	6½d.

Casing and Cover—

Best white pine	100 ft.	10/
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Conduit—

		Plain	Screwed
½ in.	100 ft.	8/9	20/
¾ in.	100 ft.	9/7	20/
1 in.	100 ft.	15/	27/6
1 in.	100 ft.	27/6	40/
1½ in.	100 ft.	45/	60/
1½ in.	100 ft.	68/	85/
2 in.	100 ft.	—	135/
¾ in. oval	100 ft.	12/6	—

Conduit Fittings—

		½ in.	¾ in.	1 in.
Grip—Tees	doz.	3/10	3/10	4/8
„ Elbows	doz.	3/	3/	3/10
„ Couplings	doz.	2/3	2/3	3/
Crampets	gross	5/5	5/5	6/3
Saddles	gross	5/	5/	5/5
		1 & ½ in.	2 in.	
Screwed tees	doz.	5/5	7/6	
„ elbows	doz.	3/9	5/5	
„ couplings	doz.	2/9	4/	
„ bell mouths	doz.	5/	5/	

Screwed Bell Mouths,	1 in.	doz.	14/10
" " "	1½ in.	doz.	19/6
" " "	1½ in.	doz.	27/
Junction Boxes—			
	¾ in. & 1 in.	¾ in.	
2-way	doz.	10/10	10/10
3-way	doz.	11/3	11/3
4-way	doz.	11/3	11/3

Holders—			
	English	Japan	
C/G., S/C. holders	doz.	11/3	8/4
¾ in. and 1 in. holders	doz.	11/3	8/4
Batten holders	doz.	12/6	9/2

Lamps—			
Metal Filament, Vacuum Type			
25 to 250 volts, 20 to 60 watt	each	2/	
20 to 250 volts, 100 watt	each	5/	
Gas-filled Type			
20 to 250 volts, 25 to 40 watt	each	2/9	
60 watt	each	3/3	
75 watt	each	3/9	
100 watt	each	5/3	
150 watt	each	7/	
200 watt	each	9/	
300 watt	each	13/	
500 watt	each	17/6	
750 watt	each	22/6	
1000 watt	each	27/6	
1500 watt	each	40/	
Carbon Filament			
All voltages, 5 to 32 candle power	doz.	24/	
All voltages, 50 candle power	doz.	42/	

Plugs—			
5 amp two pin plugs	doz.	27/6	
5 amp two pin tops	doz.	12/6	

Shades, Opal—			
8 in.	doz.	10/	
9 in.	doz.	12/6	
10 in.	doz.	15/	

Switches—			
	English		
5 amp s.p. pol. brass	doz.	16/3	
5 " s.p. ox. copper	doz.	17/11	
5 " 2-way pol. brass	doz.	30/	
5 " 2-way ox. copper	doz.	33/	
10 " s.p. pol. brass	doz.	37/6	
5 " d.p. pol. brass	doz.	37/6	
10 " d.p. pol. brass	doz.	85/	
5 " s.p. ceiling switches	each	5/6	
5 " 2-way ceiling switches	each	6/6	
1 " ceiling switch and rosette	each	5/6	
3 " American tumbler	doz.	22/6	
3 " s.p. indicating rotary	doz.	24/	
3 " s.p. non-indicating rotary	doz.	22/6	
3 " 2-way rotary	doz.	56/3	
5 " d.p. indicating rotary	doz.	62/6	
10 " d.p. indicating rotary	doz.	75/	
20 " d.p. indicating rotary	doz.	150/	

Switchboard Frames—			
6 in. x 6 in. local make	doz.	9/6	
6 in. x 8 in. local make	each	1/	
8 in. x 8 in. local make	each	1/3	
8 in. x 10 in. local make	each	1/6	
10 in. x 10 in. local make	each	1/8	

Tape—			
Black adhesive	lb.	2/9	
Pure rubber	lb.	15/	

Wire and Cables—			
	Per 1,000 yd.		
1/.044, 600 meg. ...	£7 3 4		
1/.064, 600 meg. ...	10 5 0		
3/.036, 600 meg. ...	11 15 0		+ 15%
7/.036, 600 meg. ...	20 10 0		
7/.044, 600 meg. ...	26 0 0		
7/.064, 600 meg. ...	43 10 0		

Flexibles—			
	Per 100 yd.		
23/.0076 cotton ...	£2 5 0		
40/.0076 cotton ...	2 16 8		+ 10%
70/.0076 cotton ...	3 11 8		
110/.0076 cotton ..	4 13 4		

Electrical Contracts

Full information regarding contracts invited and accepted is published every week in "Tenders," a registered newspaper issued from the office of "The Electrical Engineer." Subscription, 20/- per annum.

GENERAL

Narrabri Municipality, N.S.W.—Vickers-Petter engines, 95 h.p. (twin cylinders), and 45 h.p. (single cylinder), and Crompton d.c. generators, belt connected to engines and equipped with Lenix drive—Buzacott and Co. Ltd.

Rylstone and Kandos, N.S.W.—Reticulation works—McDonald Bros.

Walgett Shire Council, N.S.W.—Engines and generators—Moffat-Virtue Ltd.; reticulation—McDonald Bros.; switchboard and house service fuses—Electrical Manufacturers Ltd.; meters—Landis and Gyr.

NEW ZEALAND

Central Electric Power Board.—Outdoor transformers Cory-Wright and Salmon.

Franklin Electric Power Board.—Cont. No. 20, substation switchgear—A. D. Riley and Co.; cont. No. 21, busbar insulators—P. R. Bailey and Co.; cont. No. 22, lightning arresters—National Electric Co.

Invercargill Borough Council.—Electric meters (Cont. 76)—Single phase—Metropolitan-Vickers Electrical Co. Ltd.; three phase—Carrick Wedderspoon Ltd. (type H).

TENDERS OPEN—COMMONWEALTH

P.M.G.'s Dept., General.—March 23—Magnet trunk switchboards, telephone switches. March 25—Indicators. June 11—Switchboard instrument jacks and associated parts, telegraph paper, tape. June 15—Multiple twin cable and loading coils.

P.M.G.'s Dept., N.S.W.—April 1—Motor generator sets. **P.M.G.'s Dept., Queensland.**—July 6—Automatic telephone exchange equipment.

Works and Railways Dept.—March 22—Electric power installation, Elsternwick Exchange.

STATES

N.S.W. Public Works Dept.—March 24—Insulators and ironwork. June 8—3,000 kw. steam turbo alternator, boiler, steel chimney, automatic stoker economiser, etc.

N.S.W. Railways and Tramways.—March 24—Rewinding two 700 kv.a. transformers. April 21—Four motor generating sets, switch operating batteries. June 9 (time extended)—Ten ton, three motor overhead travelling crane. July 14—500 kw. turbo-alternator.

Queensland Irrigation and Water Supply Commission.—May 15—1,000 kw. steam turbo-alternator, and 750 kw. steam turbo-alternator.

South Aust. Supply and Tender Board.—March 24—Electro mechanical signalling materials.

State Electricity Commission of Vic.—March 22—G.I. street lighting brackets, pin insulator line clamps, transformer transfer trucks. March 24—Synchronous condensers and accessory plant. March 29—Transformer and auxiliary apparatus for obtaining neutral point, aluminium steel reinforced cable, electric motor driven hoists. April 12—Spec. 26/1 turbo-generators, trans-

formers, switchgear, cranes and accessory plant for Sugarloaf-Rubicon hydroelectric scheme. June 28—20,000 volt transformers and spares, 15 to 500 kv.a.

Victorian Railways.—March 17—Oil switches, 2,200-volt. March 31—Hot water heating installation recording watt meters. April 7—Electric wires and cables, electrical fittings and conduit pipe fittings. April 14—Telegraph and telephone material. April 21—Electric overhead travelling cranes, plate bending and straightening rolls and electrical equipment, balls and ball bearings, track transformers, time element relays, track and line relays. April 28—Automatic sub-station equipment, 2,200 volt cable, insulated copper wire. May 5—Rubber covered tape and braided wire for power signalling, renewals for caustic soda primary cells, track and signal transformers. June 16—Heavy current motor generating set.

Victorian Tender Board.—March 26—Electric lamps and fittings.

GENERAL

Brisbane City Council.—May 13—Special trackwork for tramway sheds.

Brunswick, Vic., City Council.—March 22—3,000 yds. 37/16 h.d. bare copper cable.

City Electric Light Co. Ltd., Brisbane.—March 22—H.T. porcelain insulators. Aug. 27—12,500 kw. turbo-alternator, two water tube boilers, etc.

Melbourne and Metropolitan Tramway Board.—April 28—Remote supervisory control gear for sub-station.

Melbourne City Council.—April 7—2,000 kw. rotary converter, etc., switchgear, and a.c. control panels. June 16—5,000/5,500 kw. turbo-alternator.

Metropolitan Water, Sewerage and Drainage Board, Sydney.—April 22—Two steam turbo pumping units.

Rockhampton, Q'ld., City Council.—March 31—Automatic voltage regulator.

Sydney City Council.—March 22—House service fuse boxes and fuses. May 3—Submarine cables, induction voltage regulators. July 12—Power transformers.

NEW ZEALAND

Public Works Dept.—March 23—Section 125, Arapuni, 22 kv.a. switchgear; section 154, filter presses and testing equipment. April 6—Section 133, Arapuni, storage battery, motor generator and switchboard. April 23—Section 158, Arapuni, 11,000-volt, metering equipment and switchgear. July 20—Section 184, Mangahao scheme, phase transformer.

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One Premier Gas Engine, 450 B.H.P.; two Mond Gas Producers, pressure types, each 550 B.H.P. for working producers alternatively; two Roots Blowers, one steam, one electrically driven. Number of spare parts. Engine with all spares £850. Producers, full equipment, £750, or complete plant £1,575. Nearest offer considered.
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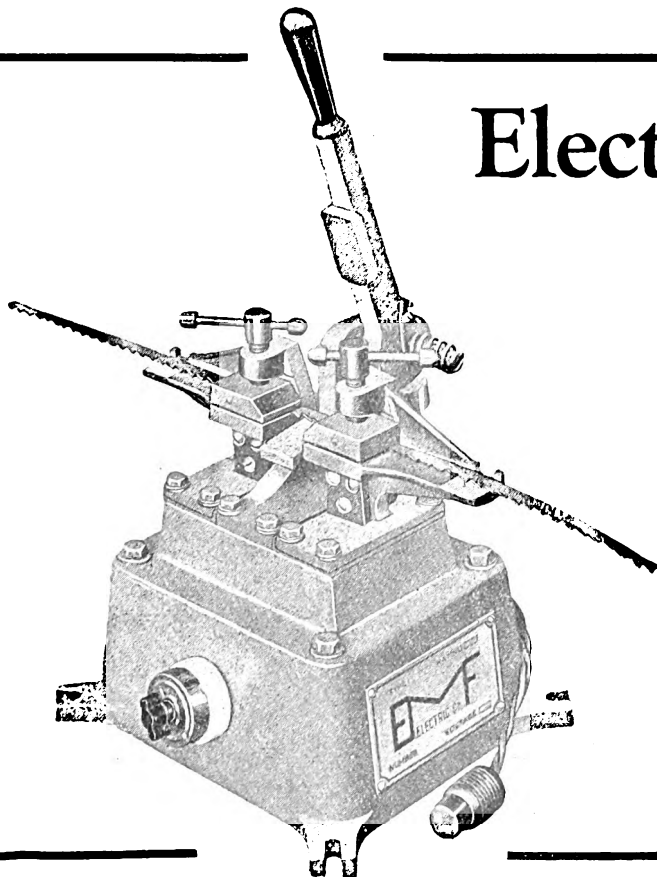
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A. R. DORE, Town Clerk

Town Hall, Albury, N.S.W., 9th April, 1925.

QUEENSLAND ELECTRICAL WORKERS' BOARD

Examinations for Certificates of Competency will be held as follow, in various centres throughout the State to suit the convenience of candidates: ELECTRICAL FITTERS and LINESMEN, 2nd June, 1925, at 7 p.m.; ELECTRICAL MECHANICS AND JOINTERS, 3rd June, 1925, at 7 p.m.

Applications from persons desirous of sitting for the examination must reach the undersigned not later than 9th May.

Application forms and further particulars may be obtained on application to

H. D. NOYES,

Secretary to the Electrical Workers' Board,

C/o Central Technical College,

Brisbane.

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Offers are invited for the purchase and removal of complete Electric Power Plant, at Pahiatua, consisting of:—

2—100 H.P. Cambridge Coal Gas Producers.

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1—88 B.H.P. twin cylinder British Westinghouse Gas Engine.

1—57 KW. 460 V. D.C. 3 Wire British Westinghouse Generator.

1—50 KW. 460 D.C. 3 Wire British Westinghouse Generator.

1—British Westinghouse Booster Balancer Set.

Complete Switchboards for above and necessary sundries. All in good order and condition.

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1—60 H.P. Tangye Gas Engine.

1—60 H.P. Tangye Coke Gas Producer.

1—230 V. 27 KW. D.C. compound Generator.

1—40 H.P. Tangye Gas Engine.

1—40 H.P. Tangye Coke Gas Producer.

Complete Switchboard for above.

1—Booster set 230 V. D.C. Motor Generator, 10/90 volts.

1—15 H.P. Boving Pelton Wheel with oil pressure governor.

1—7.5 KW. 230 V. D.C. Westinghouse Generator.

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Engineer and Manager.

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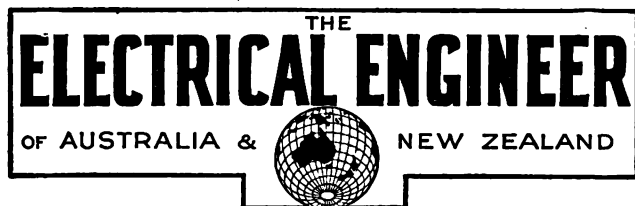
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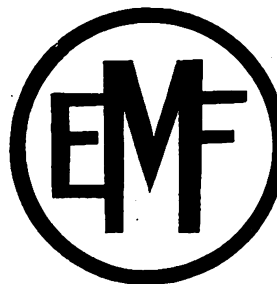
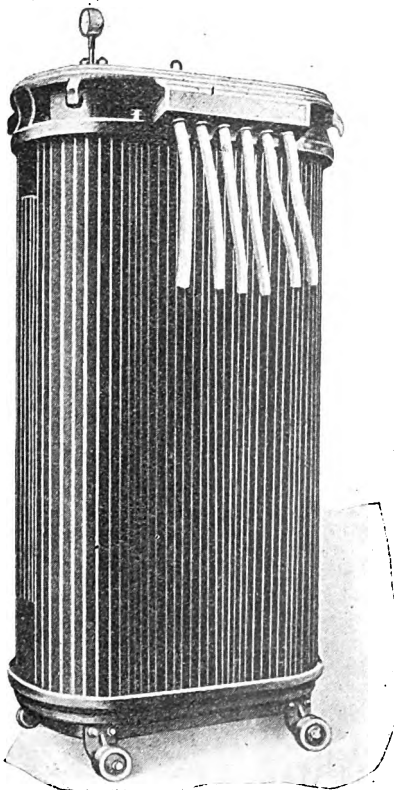
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Complete Switchboards for above and necessary sundries. All in good order and condition.

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- 1—230 V. 27 KW. D.C. compound Generator.
- 1—40 H.P. Tangye Gas Engine.
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Complete Switchboard for above

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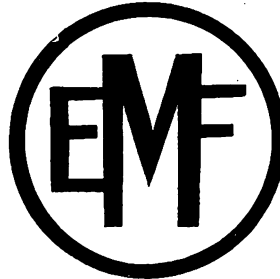
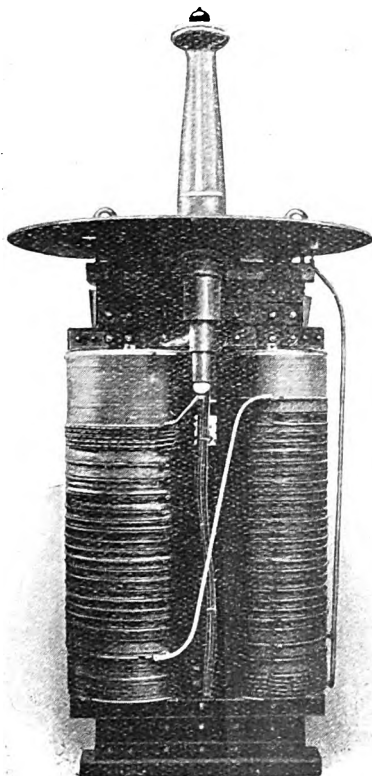
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1. METERS: 400 10-amp. single-phase, 230-volt, alternating current meters.

Supply of 10, 20, and 25 amp. three-phase, and 20 amp. single-phase 230/400 volt meters. (Approximately 5 to 10 of each will be required.)

Tenderers must quote price per meter of various classes, and forward a sample of 10 amp. single-phase meter with tender, which meter may be retained by the Council upon payment of tendered price, whether tender is accepted or not.

2. (a) ALTERNATING CURRENT 230/400 volt MOTORS. Approximately thirty in number, of varying sizes, from $\frac{1}{2}$ h.p. to 10 h.p. All motors of 2 h.p. and over to be three-phase.

(b) Alternatively, supply of the above motors, with an allowance for the taking over by the tenderer of the direct current (230/240 volt) motors now in use.

3. (a) ALTERNATING CURRENT FANS. Approximately ten 54-in. Ceiling Fans; 4 9-in. Desk Fans; 14 12-in. Desk Fans; 8 16-in. Desk Fans; 6 12-in. Exhaust Fans; 3 44-in. Ceiling Fans; 3 10-in. Desk Fans.

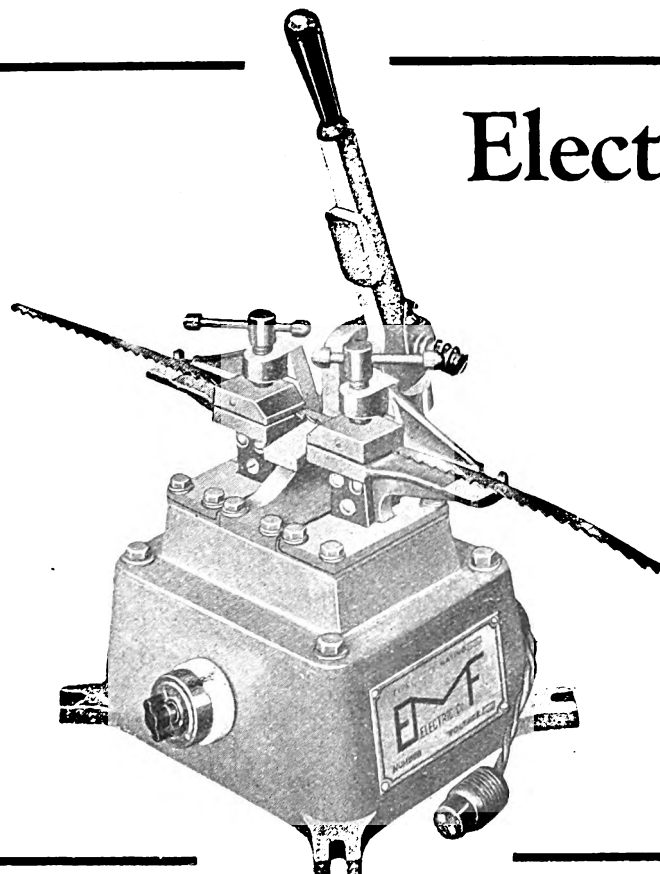
(b) Alternatively, supply of the above Fans, with an allowance made by the tenderer for the taking-over of the 230/240 volt direct current fans now in use.

Arrangements will be made for tenderers who desire to tender under clause 2 (b) or clause 3 (b) to inspect motors and/or fans on TUESDAY, JULY 21, 1925.

Any further particulars required may be obtained from the undersigned.

T. H. WEBSTER, F.I.I.S., Town Clerk.

Council Chambers, Corowa, N.S.W.
July 2, 1925.



Electric Band Saw Brazers

A necessity for all shops using band saws.
Simple to operate. Gives uniform heat
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Tenders are invited for the Supply, Delivery and Erection at Power House, Orange, of—

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TESTING INSTRUMENTS.
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Copies of Specification may be obtained on application to the undersigned, price 5/- each.

A copy of the Specification may be inspected, free of charge, at the office of A. R. Bluett, Esq., 17 Bond street, Sydney. Tenders close July 27, 1925.

F. J. MULHOLLAND, Town Clerk,
Orange, N.S.W.

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COMMENCING SALARY AT THE RATE OF £500 PER ANNUM.

Applicants should have had previous experience in the distribution of electricity and installation for public supply purposes of high pressure mains, both underground and overhead.

Applicants must state age, if married, and a full account of their engineering training, with engineering degree (if any), and applications must be accompanied by not more than four (4) recent references covering previous employment in responsible positions.

Applications close on the 1st day of September, 1925.

JOHN S. JUST,
Engineer and Manager.

ELECTRICAL ENGINEER

Age 28 years, with continental and Australian experience in hydro-electric, electric traction, overhead transmission and electric motor and transformer testing, is open for engagement in Australia or New Zealand.

"HYDRO,"

C/o. Sydney Office, This Paper.

TARARUA ELECTRIC POWER BOARD

Offers are invited for the purchase and removal of complete Electric Power Plant, at Pahiatua, consisting of:—

- 2—100 H.P. Cambridge Coal Gas Producers.
- 1—62 B.H.P. single cylinder National Gas Engine.
- 1—88 B.H.P. twin cylinder British Westinghouse Gas Engine.
- 1—57 KW. 460 V. D.C. 3 Wire British Westinghouse Generator.
- 1—50 KW. 460 D.C. 3 wire British Westinghouse Generator.
- 1—British Westinghouse Booster Balancer Set.

Complete Switchboards for above and necessary sundries. All in good order and condition.

ALSO AT EKETAHUNA

- 1—230 V. 38 KW. D.C. Compound Generator
- 1—60 H.P. Tangye Gas Engine.
- 1—60 H.P. Tangye Coke Gas Producer.
- 1—230 V. 27 KW. D.C. compound Generator.
- 1—40 H.P. Tangye Gas Engine.
- 1—40 H.P. Tangye Coke Gas Producer.

Complete switchboard for above.

- 1—Booster set 230 V. D.C. Motor Generator, 10/90 volts.
- 1—15 H.P. Boving Pelton Wheel with oil pressure governor.
- 1—7.5 KW. 230 V. D.C. Westinghouse Generator.
- 1—20 KV.A. Am. G.E. Alternator, 400/230 V. 1,500 r.p.m.
- 124 cell 290 ampere hour Tudor Battery.

Further particulars may be obtained upon application at the Office of the Board, Eketahuna, New Zealand.

R. L. GRAY, Electrical Engineer.
Engineer and Manager.

Mica Products Pty. Ltd

Registered Office and City Depot: 94/98 Queen St., Melbourne. Phone, F 1023

Works: 245 Burwood Road, Hawthorn, Vic.
Phone, Hawthorn 242

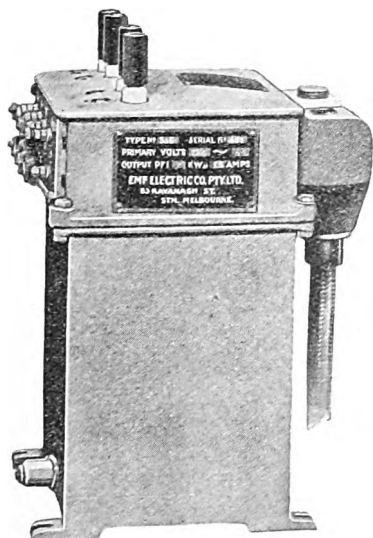
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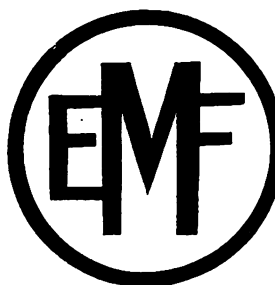
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TARARUA ELECTRIC POWER BOARD

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- 2—100 H.P. Cambridge Coal Gas Producers.
- 1—62 B.H.P. single cylinder National Gas Engine.
- 1—88 B.H.P. twin cylinder British Westinghouse Gas Engine.
- 1—57 KW. 460 V. D.C. 3 Wire British Westinghouse Generator.
- 1—50 KW. 460 D.C. 3 wire British Westinghouse Generator.
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Complete Switchboards for above and necessary sundries. All in good order and condition.

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- 1—7.5 KW. 230 V. D.C. Westinghouse Generator.
- 1—20 K.V.A. Am. G.E. Alternator, 400/230 V. 1,500 r.p.m.
- 124 cell 290 ampere hour Tudor Battery.

Further particulars may be obtained upon application at the Office of the Board, Eketahuna, New Zealand.

R. L. GRAY, Electrical Engineer,
Engineer and Manager.

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W. CLAY, Managing Engineer.
Bundaberg, QUEENSLAND.

MUNICIPAL COUNCIL OF SYDNEY

**Bunnerong Power Station—Tenders for Steam Turbo.
Alternator Plant—Specification No. 954.**

SEALED and ENDORSED TENDERS will be received by the undersigned until 3 p.m., on the 1st February, 1926, for the supply, delivery, erection, testing, etc., of STEAM TURBO ALTERNATOR PLANT for BUNNERONG POWER STATION in accordance with specification No. 954.

SPECIFICATIONS, etc., may be seen, free of charge, upon application at the office of the Construction Engineer, Electricity Department, Town Hall, Sydney, and copies may be obtained from the same office upon payment of the sum of ten shillings and sixpence (10/6) direct into the City Treasury, Town Hall, Sydney, which sum will be refunded upon the receipt of a bona-fide tender.

The lowest or any tender not necessary accepted.

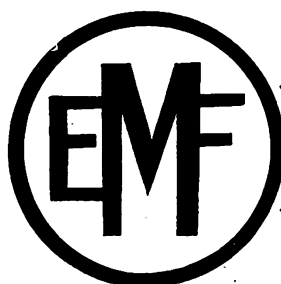
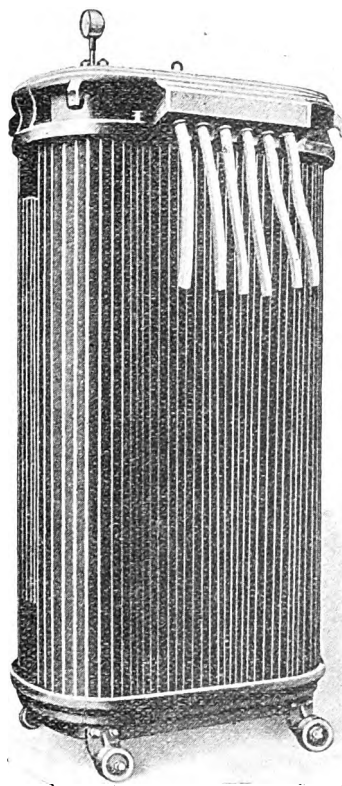
TENDERERS please note that they must pay their cash deposit direct into the City Treasury, Town Hall, Sydney, and NOT enclose it with their tender, otherwise it will be rejected as informal.

ROY HENDY, Acting Town Clerk.

Town Hall, Sydney.
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Notice is hereby given that the Proprietor of Australian Patent No. 11421/23 for an invention relating to "Oil Immersed Switch Fuses with Improved Isolating and Earthing Features," is prepared to satisfy any demand and all requirements of the public respecting the said invention.

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The Council invites enquiries and will undertake delivery F.O.B. Tauranga, N.Z.

MUNICIPAL COUNCIL OF SYDNEY.

SEALED AND ENDORSED TENDERS will be received by the undersigned until 3 p.m. on the 22nd February, 1926, for the supply and delivery of POWER HOUSE SWITCHGEAR—SPECIFICATION No. 974.

SPECIFICATIONS, etc., may be seen free of charge upon application at the office of the Construction Engineer, Electricity Department, Town Hall, Sydney, and copies may be obtained from the same office upon the payment of the sum of 10/6, direct into the City Treasury, Town Hall, Sydney, which sum will be refunded upon the receipt of a bona fide tender.

The lowest or any tender not necessarily accepted.

TENDERS please note that they must pay their preliminary deposit in cash direct to the City Treasurer, Town Hall, Sydney, and NOT enclose it with their tender, otherwise their tender will be rejected as informal.

W. G. LAYTON, Town Clerk.

Town Hall, Sydney,
2nd October, 1925.

MUNICIPAL COUNCIL OF SYDNEY.

SEALED AND ENDORSED TENDERS will be received by the undersigned until 3 p.m. on the 30th November, 1925, for the purchase of the following SECOND HAND ROTARY CONVERTER SETS:—

- 2—1,500 kilowatt 3 wire balancing rotary converters and transformers suitable for converting 6,600 volts 25 cycles 3 phase alternating current to direct current at 480/520 volts. These machines may also be used for converting to direct current at 600 volts.
- 2—1,000 kilowatt 3 wire balancing rotary converters and transformers suitable for converting 6,600 volts 25 cycles 3 phase alternating current to direct current at 480/520 volts.

Specifications and full particulars may be obtained free of charge upon application at the office of the Electricity Department, Town Hall, Sydney.

The highest or any tender not necessarily accepted.

TENDERS please note that they must pay their preliminary deposit in cash direct to the City Treasurer, Town Hall, Sydney, and NOT enclose it with their tender, otherwise their tender will be rejected as informal.

W. G. LAYTON, Town Clerk.

Town Hall, Sydney,
2nd October, 1925.

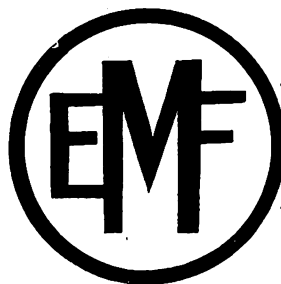
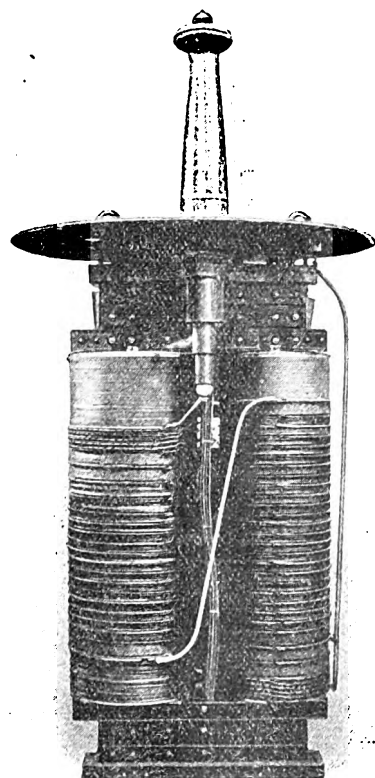
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Power and Lighting Transformers of all sizes
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First Class Material and Workmanship.

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Sixth Edition

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MUNICIPAL COUNCIL OF SYDNEY.

**BUNNERONG POWER STATION—TENDERS FOR STEAM TURBO
ALTERNATOR PLANT—SPECIFICATION NO. 954.**

SEALED and ENDORSED TENDERS will be received by the undersigned until 3 p.m. on the 1st February, 1926, for the supply, delivery, erection, testing, etc., of STEAM TURBO ALTERNATOR PLANT for BUNNERONG POWER STATION in accordance with specification No. 954.

SPECIFICATIONS, etc., may be seen, free of charge, upon application at the office of the Construction Engineer, Electricity Department, Town Hall, Sydney, and copies may be obtained from the same office upon payment of the sum of ten shillings and sixpence (10/6) direct into the City Treasury, Town Hall, Sydney, which sum will be refunded upon the receipt of a bona fide tender. The lowest or any tender not necessarily accepted.

TENDERERS please note that they must pay their cash deposit direct into the City Treasury, Town Hall, Sydney, and NOT enclose it with their tender, otherwise it will be rejected as informal.

ROY HENDY, Acting Town Clerk.

Town Hall, Sydney, 11th September, 1925.

ELECTRIC MOTOR AGENCY

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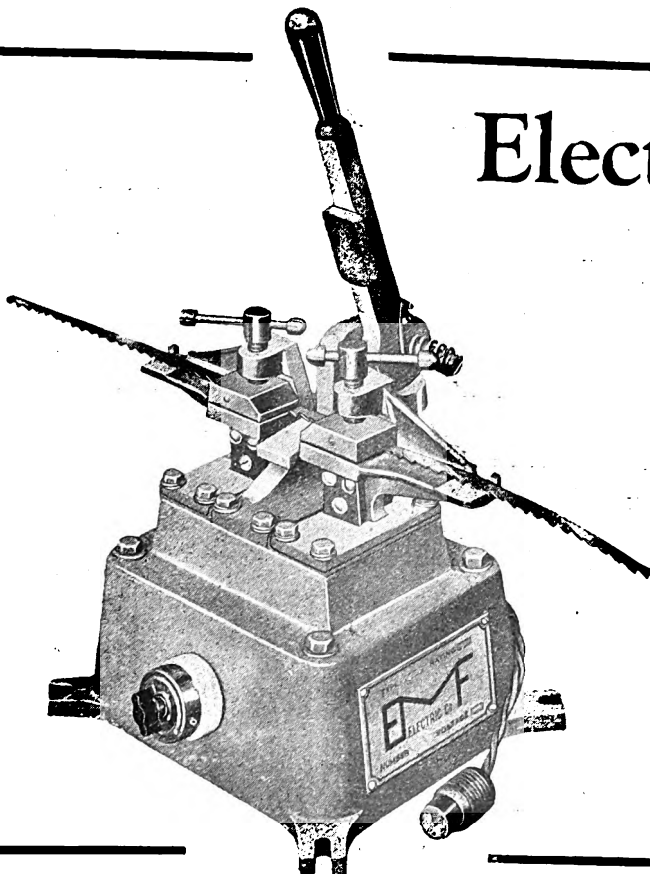
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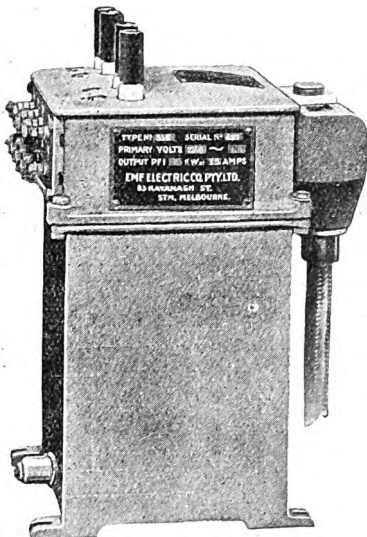
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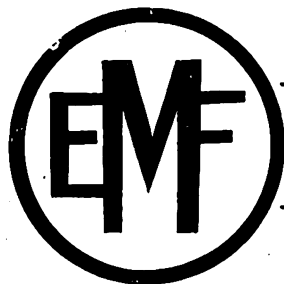
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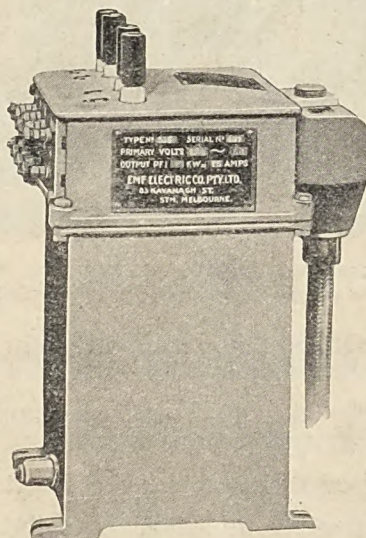
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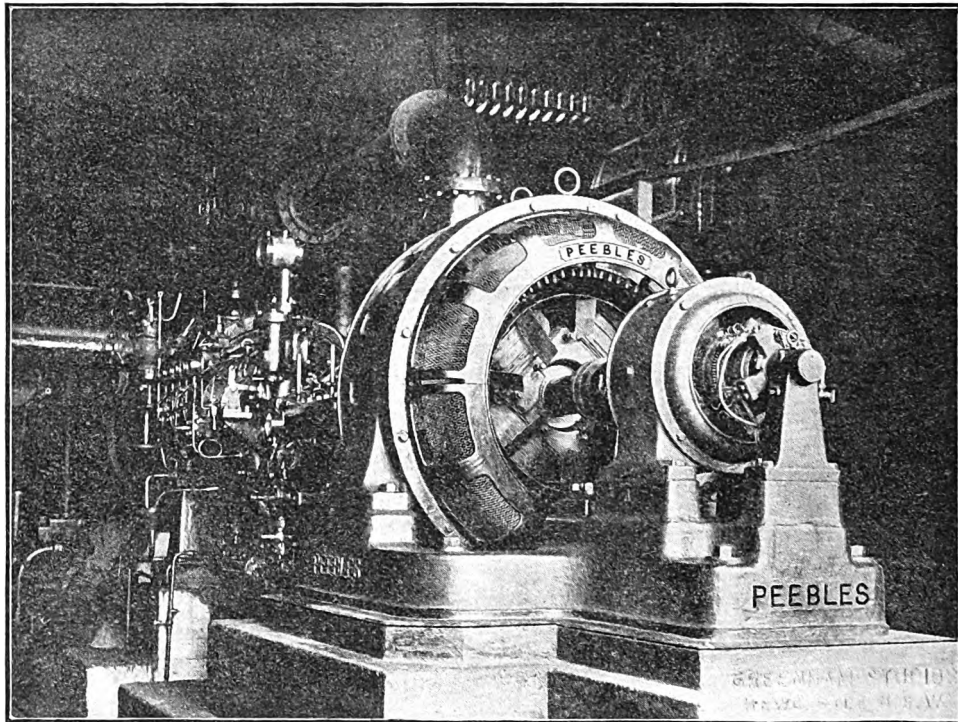
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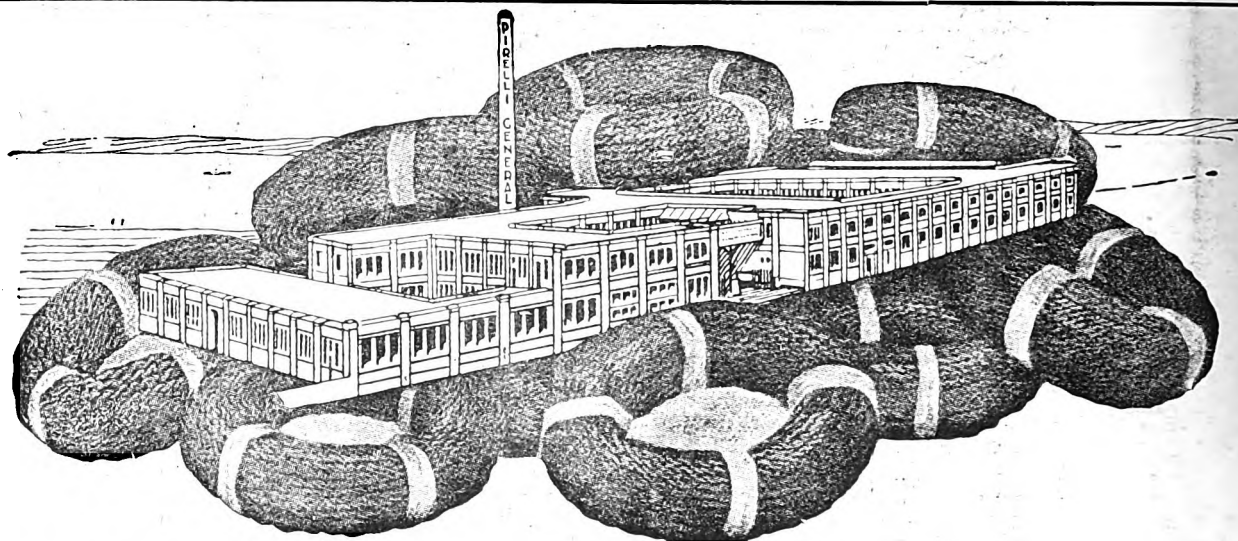
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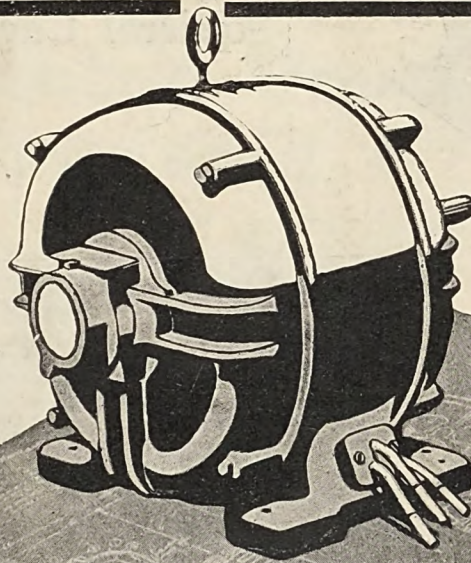
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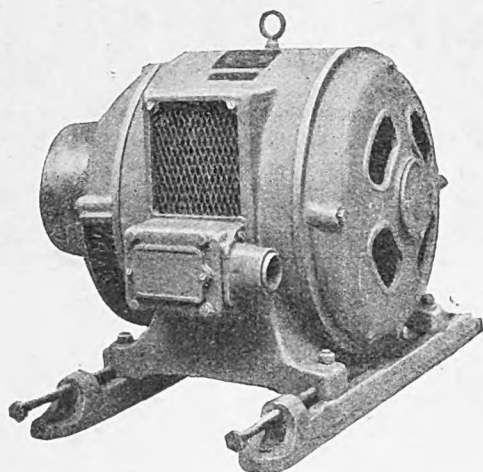
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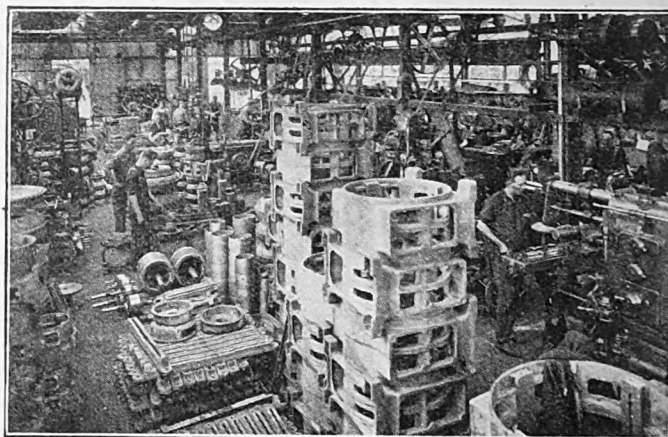
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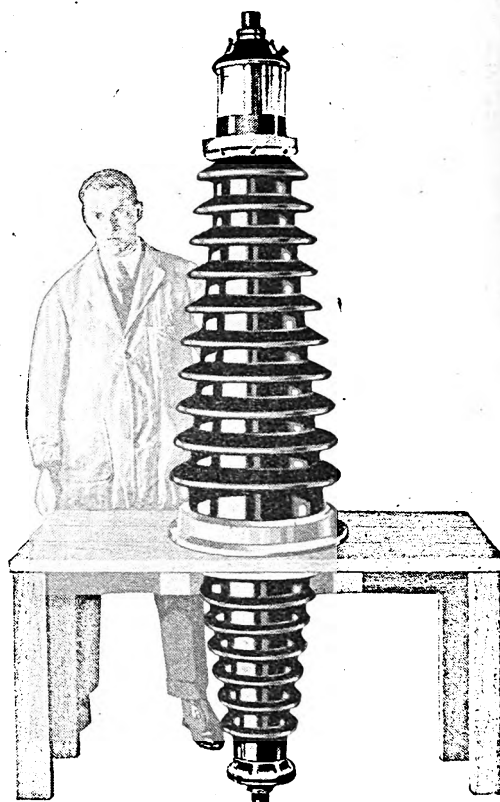
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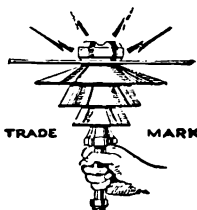
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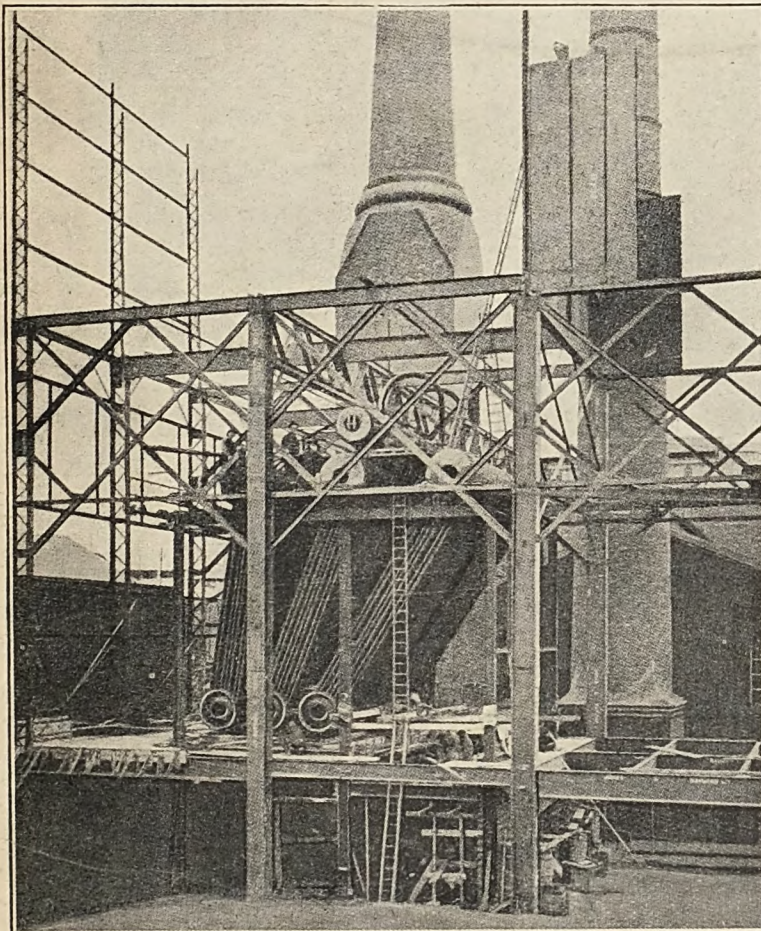
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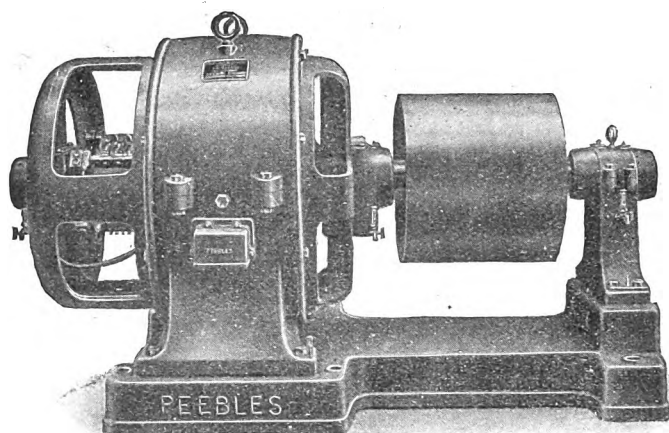
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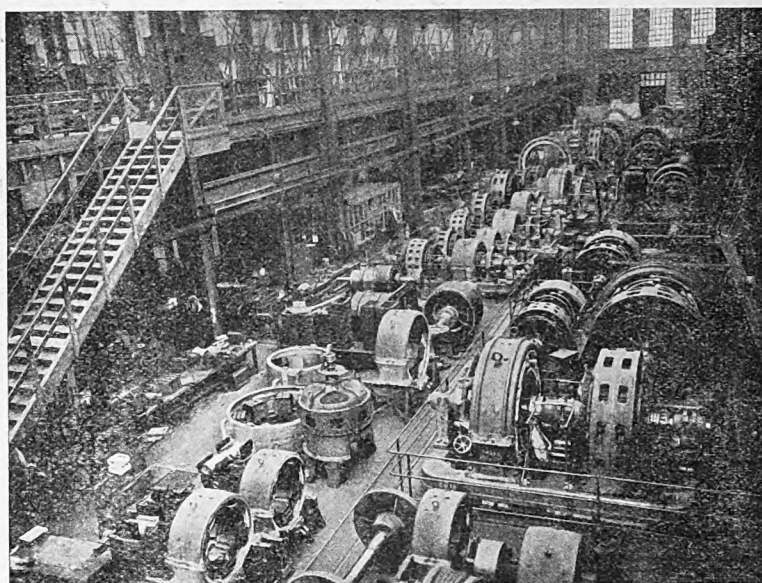
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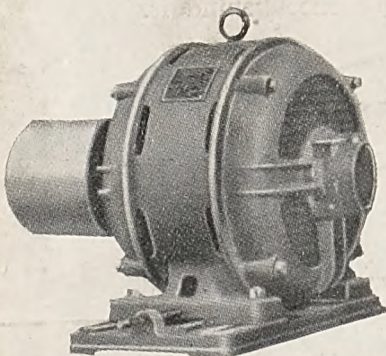
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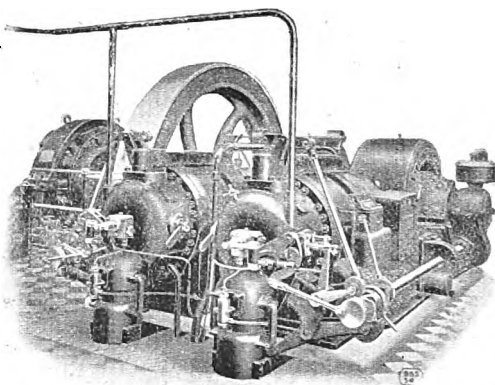
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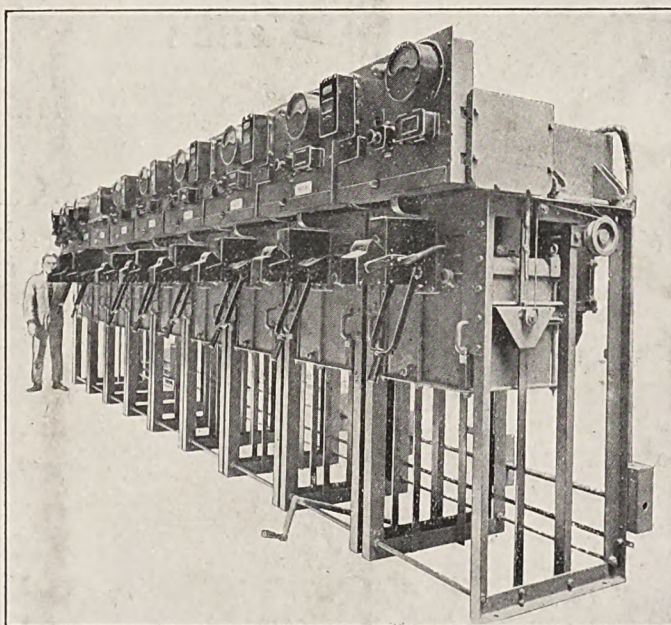


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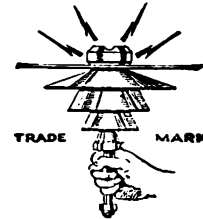
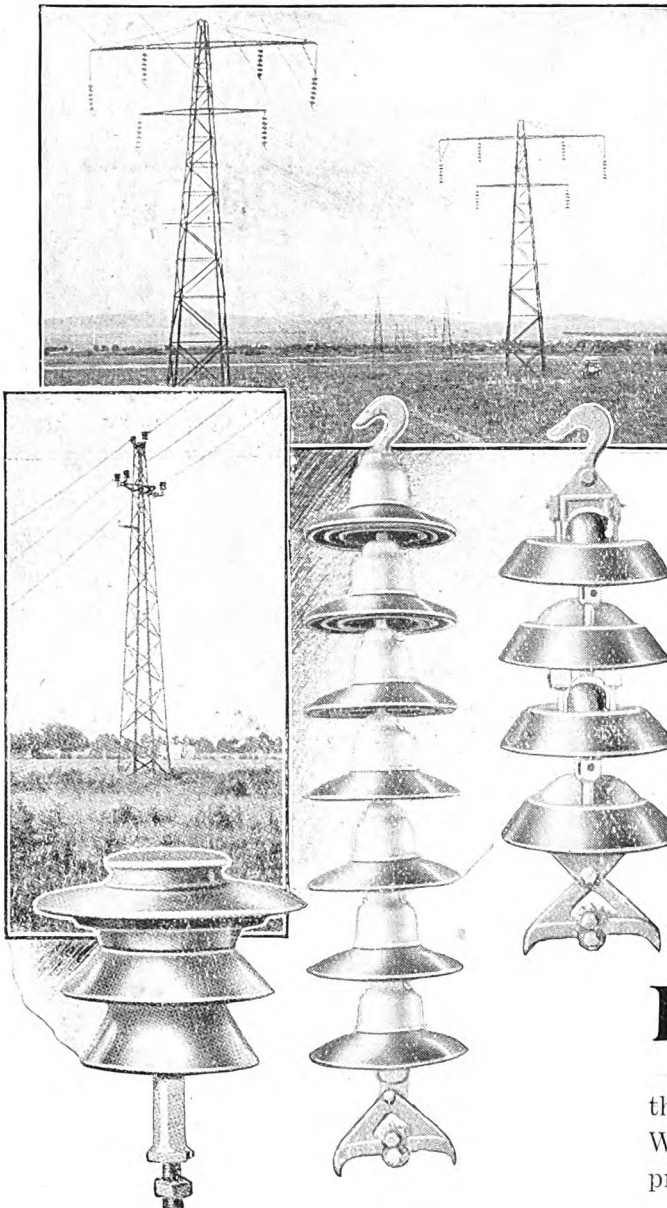
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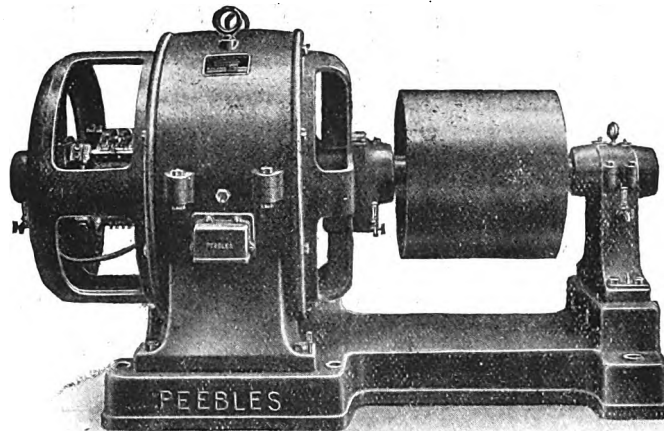
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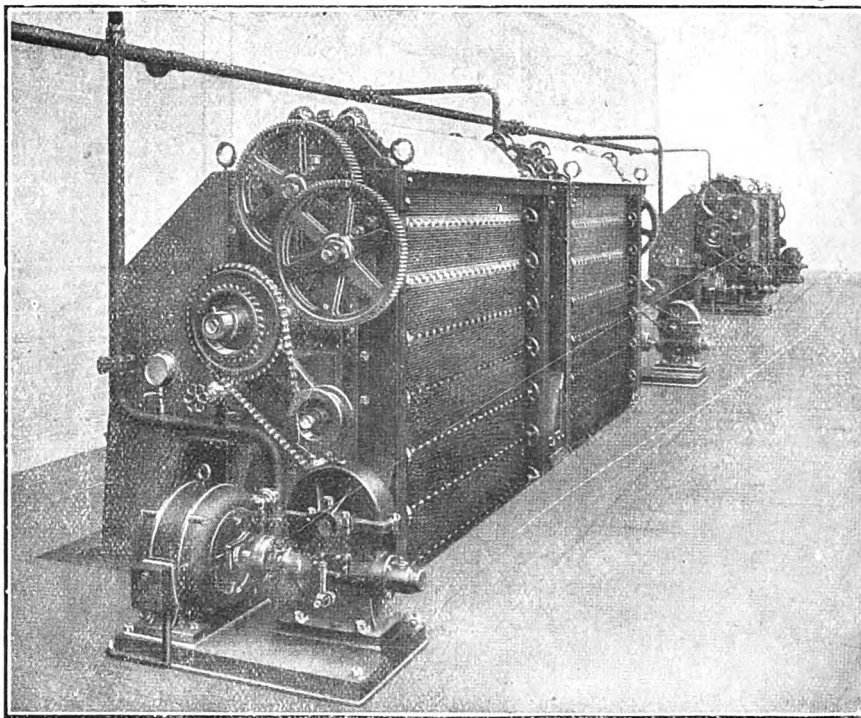
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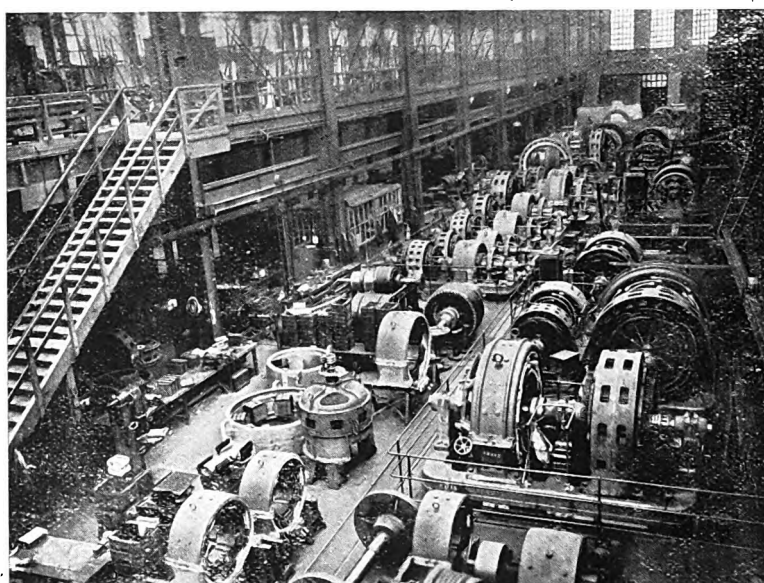
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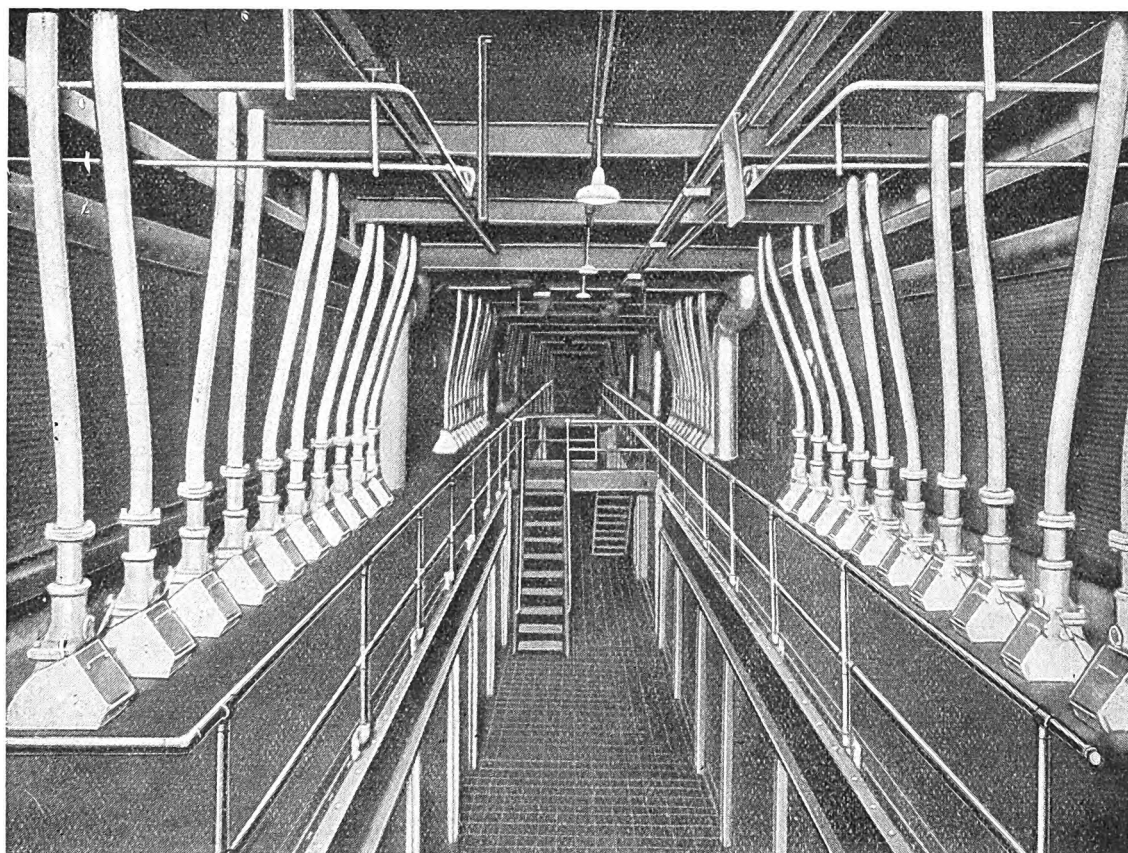
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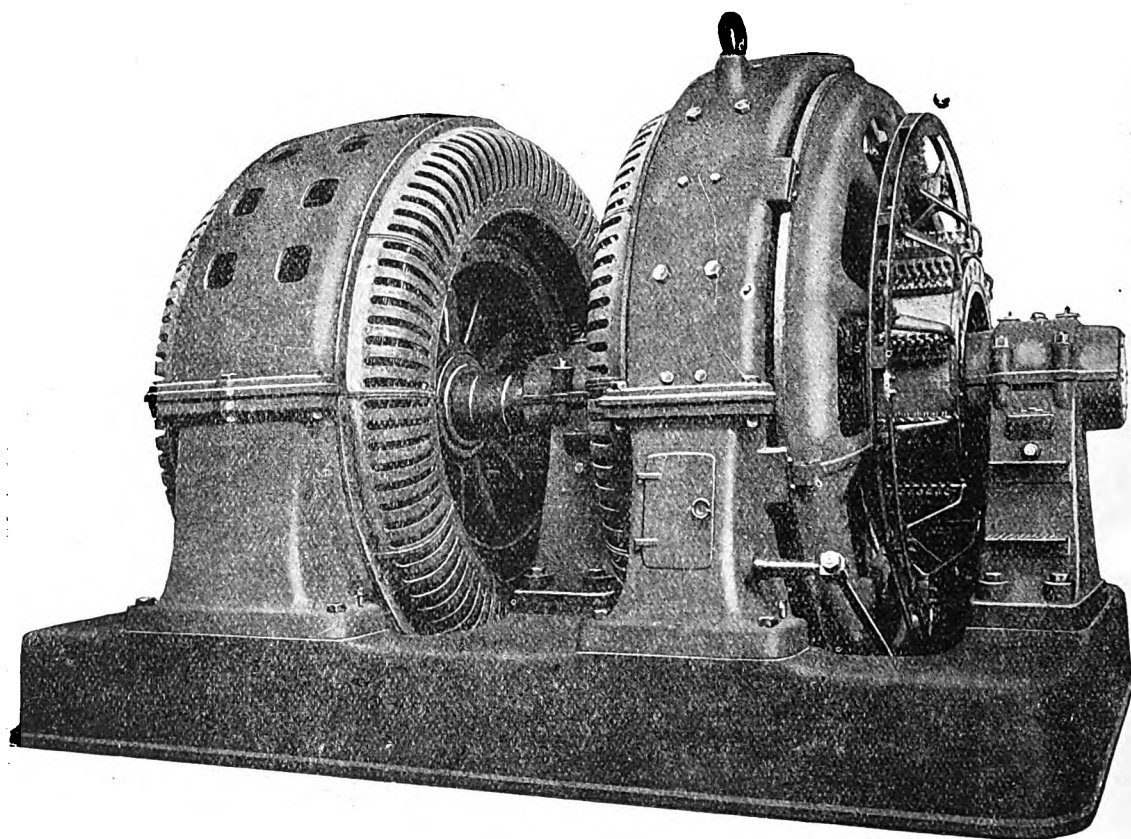
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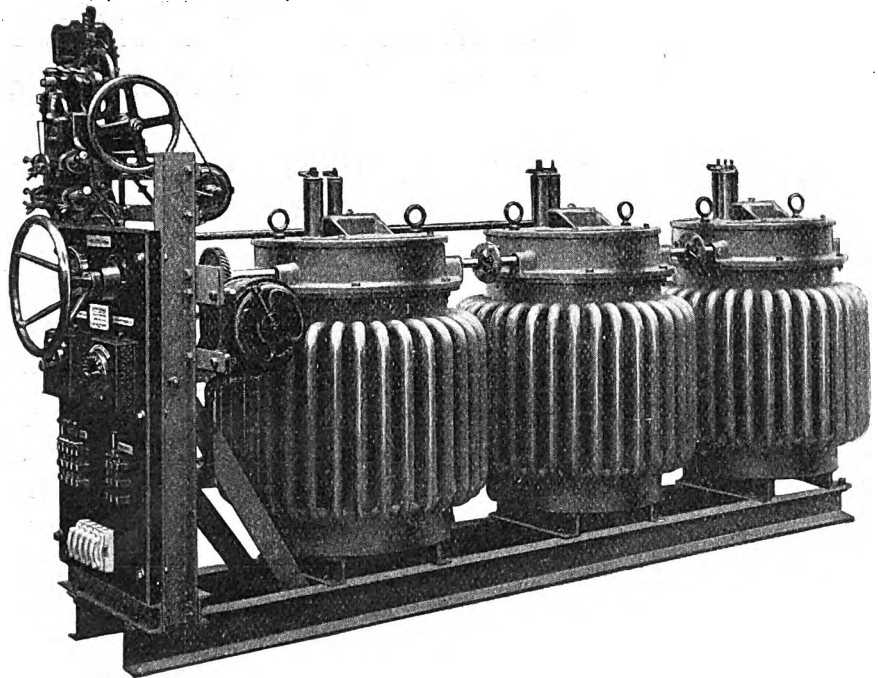
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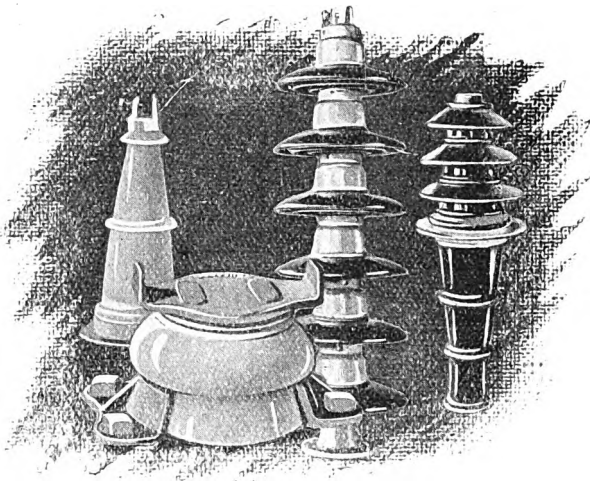


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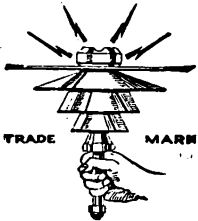


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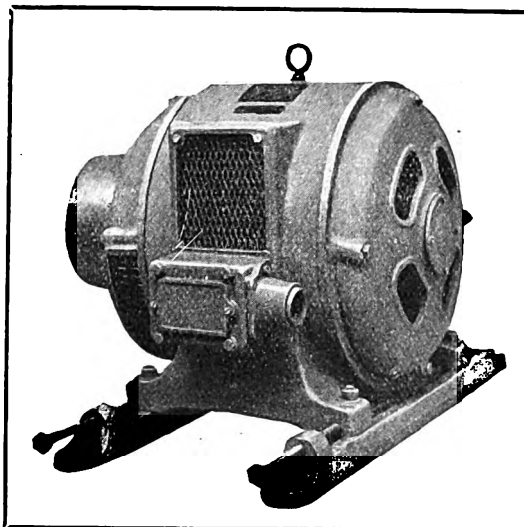
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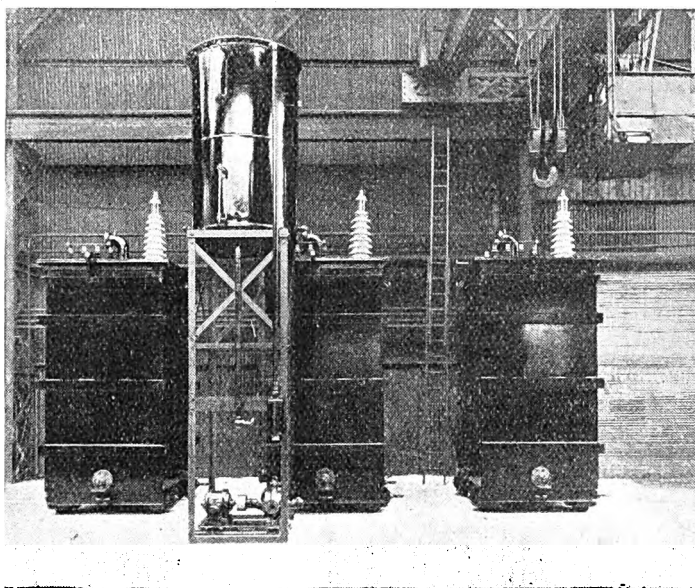
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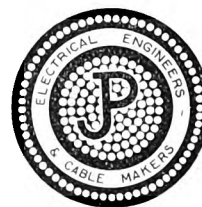
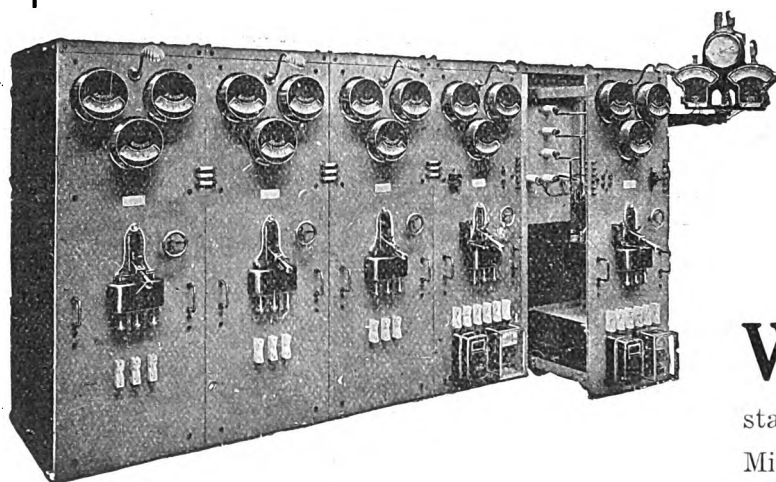
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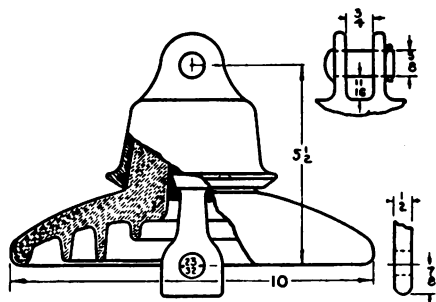
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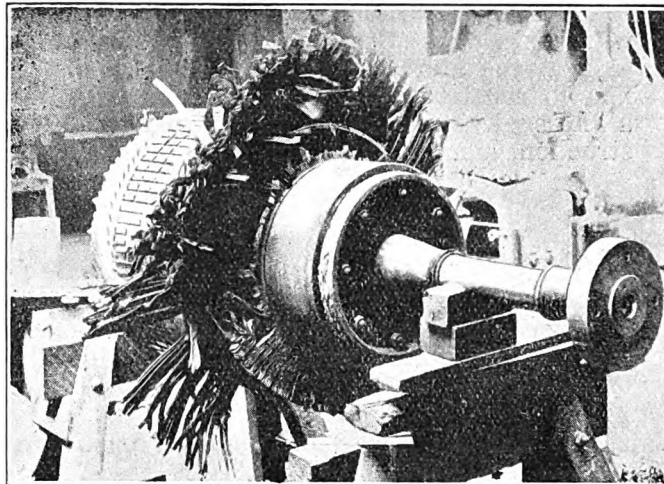
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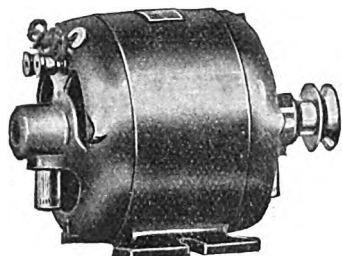


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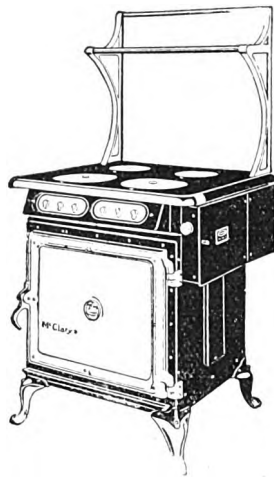
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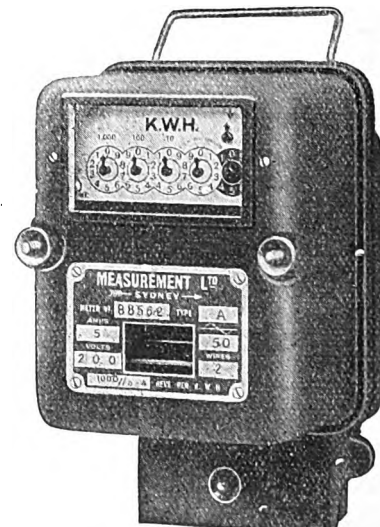
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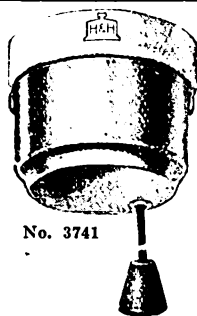
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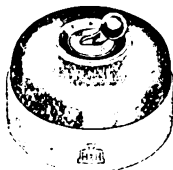
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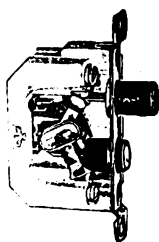
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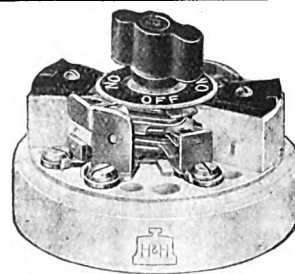
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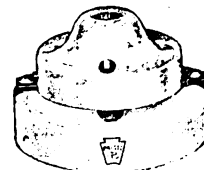
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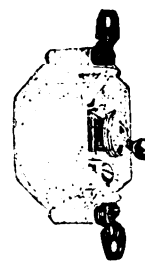
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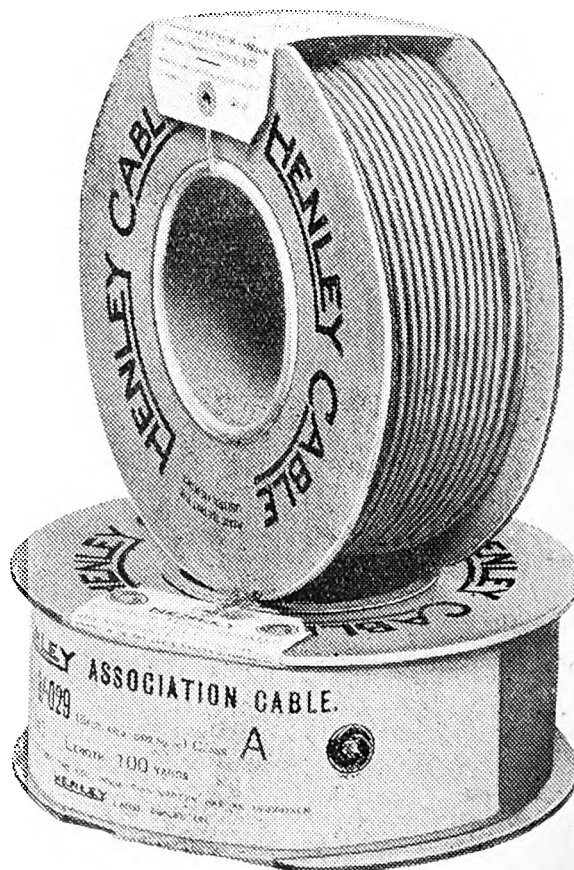
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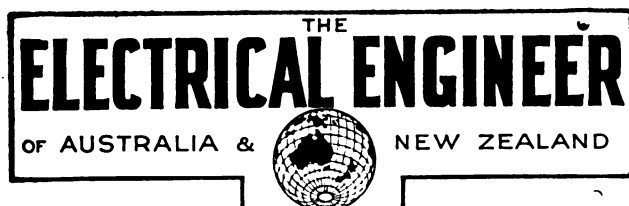
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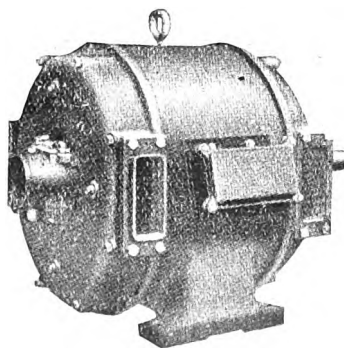
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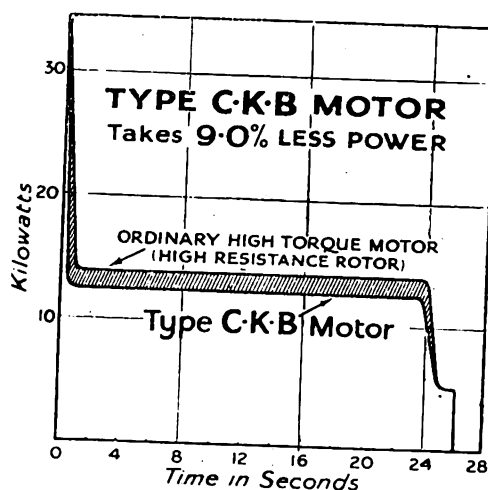
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